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The Journal of the Department of Agriculture of Victoria, Australia.

April, 1923.

PRINCIPAL CONTENTS

The Water Requirements of Farm Crops

Successful Dairy Farming

Dookie Crop and Fallow Competition

Diseases of the Cotton Plant

Weeds and their Eradication

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OF

THE DEPARTMENT OF AGRICULTURE,

VICTORIA, AUSTRALIA.

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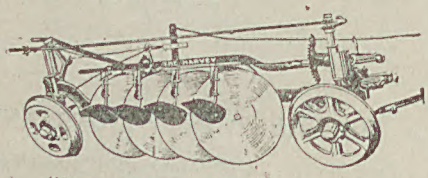

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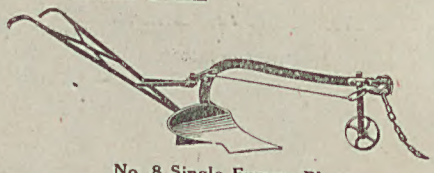

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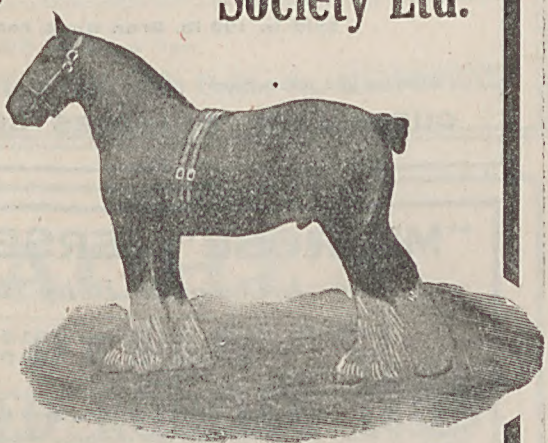

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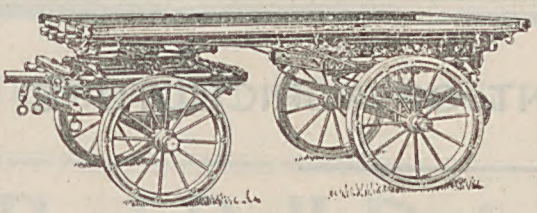

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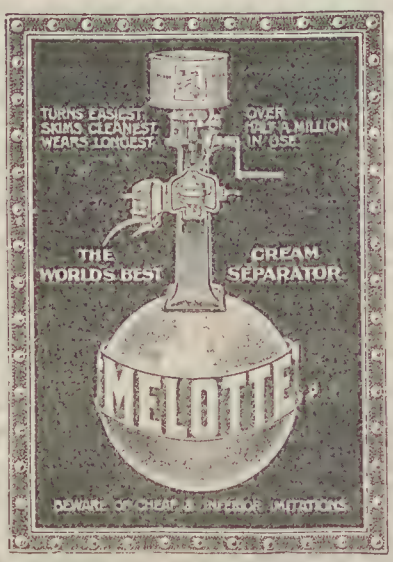

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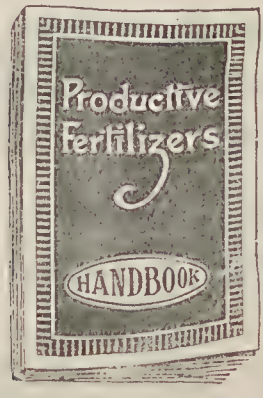

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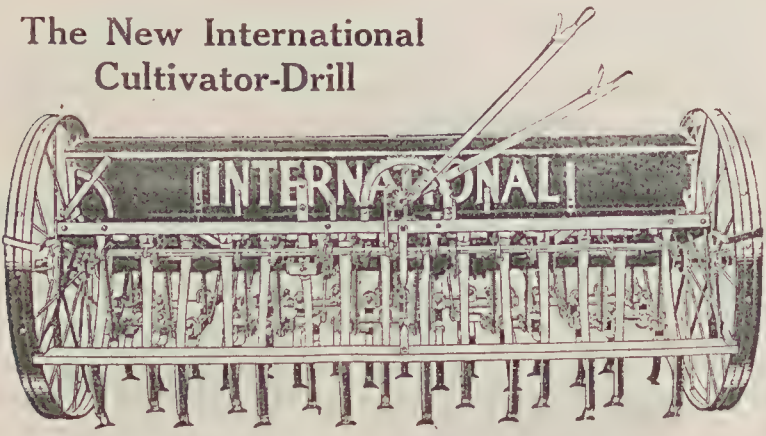

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THE JOURNAL

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VICTORIA.

Vol. XXI. April, 1923. Part 4.

THE WATER REQUIREMENTS OF FARM CROPS.

INFLUENCE OF ENVIRONMENT ON THE TRANSPIRATION RATIO.

By A. E. V. Richardson, M.A., B.Sc., Agricultural Superintendent, Victoria.

The quantity of water used in the growth of farm crops is so considerable that the water supply of the soil is frequently a limiting factor in crop production.

There are millions of acres of good soil in regions where the rainfall is just below the amount necessary to make crop raising profitable with existing methods of cultivation.

There are other regions where the rainfall would be sufficient if it were properly distributed, or if crop growth could be adjusted to use the rainfall economically. It has long been known that crops differ materially in their water requirements, but more recently it has been shown that soil and climatic conditions—*i.e.*, environmental conditions —profoundly affect the water requirements of a given crop. These are matters of scientific interest, and of great practical importance, more especially in countries with a large area of land of low rainfall.

Any investigations which will throw light on the relationship between the available moisture in the soil and the magnitude of crop production, are of fundamental importance to countries with large areas of arid land.

Investigations relating to the water requirements of farm crops have been carried out in Europe, India, and the United States of America, but hitherto this subject has received no attention from workers in Australasia.

This paper gives an account of investigations conducted over a period of five years to determine, for Victorian conditions, the relative water requirements of farm crops, and the influence of season, degree

of moisture-saturation, fertilizers, and different crop varieties on the transpiration ratio for dry matter and grain.

The plant physiologist has devoted much attention to the organs of the plant which control transpiration, and has compared the losses by transpiration with the leaf area, relative abundance of stomata, the activity of the upper and lower sides of the leaf, &c. In such investigations the water transpired is usually expressed in terms of unit area of leaf.

The relation between transpiration and temperature, light, humidity, has also been measured, but usually only for short periods of time, and with plants of non-agricultural interest.

For the determination of water requirements of farm crops, we desire to know how much water is used by the crop throughout its period of growth, and we need a method of expressing the quantities that will apply to all cases. The usual method is to express the quantity of water transpired in terms of dry matter produced. The water requirement of any given crop is the ratio of the weight of water transpired by the crop during growth to the dry matter produced. This is called the Transpiration Ratio.

Summary of Previous Investigations.

The earliest determinations of the water requirements appear to have been made by Woodward (1699). Woodward used water cultures, and grew plants of known green weight in stoppered vials, and kept an accurate record of the water consumed.

He found that the water requirements of plants grown in spring and rain water were higher than of those grown in water containing more soluble matter, and that when impure water was distilled the water requirement was higher when plants were grown in the distillate than when grown in the residue.

Most of the earlier workers who studied transpiration did not carry their plants beyond the seedling stage. Lawes (1850) was the first to study transpiration for the whole period of growth of a crop. He appears to have been the first to determine the influence of fertilizers on the water requirements of the crop. According to his results, the average transpiration ratio for wheat, barley, and clover was reduced from 258 to 209 by the use of mixed mineral and ammoniacal manures.

Fittbogen (1873) determined the effect of varying degrees of soil saturation on the water requirement of oats. He concluded that the water requirement of oats decreased gradually with decreased water content.

Marie-Davy (1875) reported experiments designed to show the effect of soil type on the water requirement of wheat expressed in terms of grain produced.

Wollny (1877) determined the water requirements of crops in pots measuring 13 x 20 centimetres. Surface evaporation was prevented from the pots. He records ratios ranging from 233 in the case of maize to 912 for buckwheat.

Hellriegel (1883) determined the water requirements of eight types of crops, and tested the effects of fertilizers and varying degrees of moisture saturation on the Transpiration Ratio. His results generally

indicate that the water requirement varies with the crop, the water content of the soil, and the type of fertilizer used. He used open pots containing four kilos of sand, and a correction had to be made for direct evaporation from the soil, and this introduced an element of uncertainty into his results.

King (1892-95 and 1905) conducted a large number of tests under field conditions with maize, barley, oats, clover, and potatoes, in barrels and large pots. No attempt was made to check surface evaporation, nor was any attempt made to correct for surface evaporation; consequently, his results are inconclusive.

Heinrich (1894) showed that the water requirement of oats grown in water cultures is increased if the nutrient solution is lacking in any nutrient. He also found that the transpiration ratio decreased as the concentration of the nutrient solution was increased.

Liebscher (1895) measured the water requirements in clay and sand treated with varying fertilizers. Complete fertilizer gave a lower water requirement, both in sand and clay, than the check pots.

Schrœder (1896) showed that there was a reduction in the water requirement of barley when the moisture content of the soil was decreased.

Wilfarth and Wimmer (1902) determined the effect of potash and other salts on the water requirements of potatoes, tobacco, buckwheat, mustard, and oats in the field, in pots 15 x 20 c.m., and 22 x 20 c.m. In general, the experiments showed a decided decrease in the water requirements for potatoes when moderate amounts of potash are added. The addition of nitrogen lowered the water requirement. Surface evaporation from the soil was not prevented, nor was a correction made for evaporation.

Ohlmer (1908) compared the water requirements of crops with varying combinations of fertilizers in open pots, maintained at 45 per cent. and 75 per cent. of water-holding capacity. The lower water content in all cases gave a lower water requirement.

Wimmer (1908) tested the water requirements of chicory, ryegrass, beets, and carrots in pots 20 x 33 c.m., under field conditions. Nitrogen lowered the water requirement, but potash did not produce any material effect.

Widstoe (1909) measured the water requirements of maize and wheat in four types of soil, in pots 61 x 76 c.m. The experiments extended over four years, and showed clearly that crops grown in unproductive soils had an increased water requirement. He also determined the effect of fertilizers on the water requirements of maize. The results show a reduction in the water requirement with the fertilizer, but the effects varied with the season.

Leather (1910-11) investigated the water requirements of crops grown in various types of Indian soils, effect of fertilizers and soil mass on the water requirements. He found that the same crop showed a wide variation in water requirements when grown on different soils. The factor influencing the Transpiration Ratio appeared, however, to be the plant food of the soil rather than the texture of the soil. He also showed that there was a reduction in the water requirement when liberal dressings of fertilizers were applied. His data are conclusive as to the effect of soil mass on the water requirement. An insufficient soil mass

increases the water requirement, probably because of insufficient food supply.

Kiesselbach (1910) determined the water requirement of maize grown in river sand kept saturated with Schimper's normal nutrient solution. Four concentrations were used, and the plants were grown in the field in potometers 25 x 30 c.m. With the exception of the highest concentration, which reduced the growth of plants, the results showed a slight increase in the water requirement as the concentration of the solution was diminished.

Kiesselbach and Montgomery (1911) grew maize in covered pots 41 x 91 c.m., under varying conditions of soil saturation, ranging from 35 per cent. of saturation to 100 per cent. There was a very small margin of available moisture in the driest pots, and the crops often wilted. The results generally indicated a greater water requirement for high saturation than for low degrees of saturation.

Montgomery and Kiesselbach (1912) determined the water requirement of maize grown in three types of soil—fertile, intermediate, and infertile. The pots, 41 x 91 c.m. in size, were covered, and clay was used at the joint between the cornstalk and the oilcloth cover to exclude rain. A reduction in the water requirement was observed with an increase in soil fertility, and when liberal dressings of fertilizers were used, the water requirements from all three types were uniform.

Briggs and Shantz (1913, 1914, 1915) conducted tests in Akron, Colorado, with over 100 different crops and varieties, in pots 41 x 61 c.m., inside a screened enclosure. Surface evaporation was prevented by the use of tight-fitting covers, and rain was excluded. The crops tested show a range in water requirements varying from 275 for millet to 1,068 for lucerne.

Kiesselbach (1916) records the results of experiments showing the relationship between humidity and transpiration and ash content. Maize was grown in pots 41 x 91 c.m. The results showed that the water loss from a maize plant is affected in a similar manner by changing climatic conditions, as the evaporation from a free water surface. The transpiration rate is dependent upon humidity. A difference of 22 per cent. in relative humidity and 1.7° F. during the day caused a difference of 42 per cent. in the Transpiration Ratio, 38 per cent. in the transpiration from a unit of leaf area, and 46 per cent. in the evaporation from a free water surface. Transpiration produced a marked reduction in leaf temperature. An increase in atmospheric humidity which lowered the evaporation 47 per cent., reduced the water transpired per gram of ash content 38 per cent., and per gram of dry matter 40 per cent. Less water was transpired per gram of ash content, and also per gram of dry matter, in a relatively low soil saturation than where an abundance of water was used.

Hasselbring (1914) determined the effect of shading on transpiration. Tobacco plants grown in the open absorbed 28 per cent. more water than those grown in shade. Plants which transpired the greater quantity of water contained the smaller percentage and smaller absolute quantity of ash.

Briggs and Shantz (1916) recorded the results of investigations to show the extent of correlation between transpiration and the physical factors of environment. Continuous automatic records were obtained

of air temperature, solar radiation, wet-bulb depression, wind velocity, evaporation from a water surface.

The correlation co-efficients between transpiration of different crops, considered both individually and as one population, were as follows:—

Transpiration with radiation	.50	± .01
„ temperature	.64	± .01
„ wet bulb depression ..	.79	± .01
„ evaporation (shallow tank) ..	.72	± .01
„ „ (deep tank) ..	.63	± .01
„ wind velocity	.26	± .01

Wet bulb depression and evaporation from a shallow tank exhibit the highest correlation with transpiration in all cases, while wind velocity is correlated with transpiration only to a very slight extent.

Weaver (1916) reported results of experiments with transpiration of plants affected by cereal rust. The presence of a small amount of rust accelerates the transpiration rate, and a close quantitative relationship was established between the amount of pustular area and the increase in transpiration. He concluded that under conditions of disease the transpiration rate might be so excessive as to hinder the normal activities of the plant.

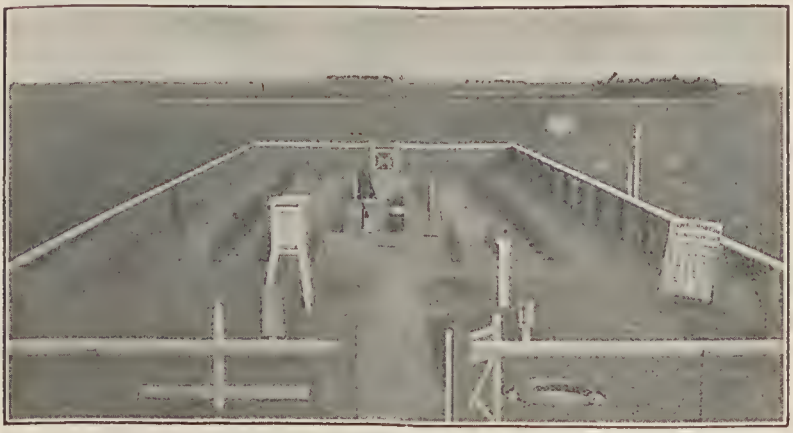


Fig. 1.—General view of Pot Enclosure, Werribee, used for the determination of the water requirements of plants.

The pots are kept at ground level in order to prevent fluctuations in temperature In the foreground is meteorological apparatus for recording (*a*) air and soil temperatures; (*b*) hours of bright sunshine; (*c*) humidity; (*d*) rate of evaporation.

Method of Determining the Water Requirement of Crops.

The determination of water requirement of crops under actual field conditions is a matter of considerable difficulty, because of the experimental errors involved in determining the losses from the soil by evaporation, seepage, and run off.

It necessitates the measurement of added water and the estimation of the difference in the water content of the soil at the beginning and end of the experiment. This latter cannot be carried out with sufficient accuracy to give reliable data.

The most satisfactory method of determining the water requirement is to grow the crops in pots, and to determine the transpiration by loss in weight of the pot with its contained plant. The growing of crops in pots involves departure from field conditions, but for a comparative study of different crops grown in a uniform manner, no serious error is involved. The use of pots eliminates losses by seepage, and the only water losses are those caused by transpiration by the crops, and evaporation from the soil.

To obtain accurate records of transpiration, the losses by evaporation from the soil must be either eliminated or reduced to negligible amounts.

Check pots without plants, *i.e.*, check pots of bare fallow, may be used, provided proper precautions are taken to represent the losses by evaporation. If pot experiments are conducted under field conditions, and the crops are exposed to rain, the losses from the fallow pots may be considerable, especially where light showers followed by high winds

Fig. 2.—Pot experiments to determine the water requirements of farm crops.

Each pot holds 280 lbs. of soil. Pots 1 and 8, Bare Fallow; 6 and 11, Algerian oats; 2 and 9, Federation wheat; 5 and 10, Cape barley; 3 and 7, Lucerne. On the right is the water collector, and in the foreground a rain gauge. The pots are placed in the soil in order to keep the temperature of the pot the same as that of the surrounding soil.

are frequent. The water lost by evaporation may then form a considerable proportion of the total losses by transpiration and evaporation, in which case the experimental error may be considerable.

If the tests are made in an enclosure protected from rain, evaporation losses may be reduced to negligible amounts by the use of fine gravel mulches on the surface of cropped and fallow pots, and by applying the water necessary through specially constructed watering tubes.

Water Requirements under Field Conditions.

The first investigation was conducted in pots under field conditions at the State Research Farm, Werribee, in 1914.

The object of the test was to determine the transpiration ratio for wheat, barley, oats, lucerne, and summer-grown wheat, and to measure the rate of transpiration of the crops at different seasons of the year.

The pots used in the experiment were made of galvanized iron strengthened by circular bands, and fitted with handles and air tubes. The air tubes were required in times of heavy rainfall to remove surplus water from the pots and to prevent water logging.

The pots were 15¾ inches in diameter and 27 inches deep, and held 250 lbs. of soil, at 50 per cent. of saturation.

The pots were filled with Werribee clay loam resting on clay subsoil. A layer of coarse gravel was placed at the bottom of the pot to facilitate drainage, and a layer of fine gravel on the surface to reduce evaporation. The pots were placed in the ground to a depth of 25 inches, with the soil surface in the pots on ground level. They were exposed to weather in a wheat field, and corrections made for rain and evaporation.

The amount of water falling on the pots was measured by two standard rain-gauges and two specially constructed water measurers, with the same catchment areas as the pots, but fitted with a funnel which conveyed the water into a closed receptacle. The amount of rain water collected in the water measurers was checked against the quantity of rain registered in the gauges each day.

The pots were weighed weekly throughout the growing period on a steelyard turning to a one-tenth of a pound, and the pots were brought to constant weight each week by the addition of water. The season proved to be one of the severest droughts on record.

The following table summarizes the results obtained:—

Table Showing Water Requirements of Crops Grown under Field Conditions, State Research Farm, Werribee, 1914-15.

Crop.	Period of Growth. (days).	Water Used.	Water Lost by Evaporation.	Water Transpired.	Weight of Dry Matter Produced.			Transpiration Ratio.	
					Straw.	Grain.	Total.	Dry Matter.	Grain.
Wheat—		lbs.	lbs.	lbs.	grams.	grams.	grams.		
Federation ..									
Pot 2 ..	210	134·5	52·1	82·4	55·95	36·80	92·75	402 } 409·5	1,013
Pot 9 ..	210	139·2	52·1	87·1	57·49	37·01	94·50	417 }	1,065
Barley—									
Cape—									
Pot 5 ..	203	131·8	49·4	82·4	59·30	44·96	104·26	312 } 337·1	712
Pot 10 ..	203	150·4	49·4	101·0	72·75	53·28	126·03	362 }	818
Oats—									
Algerian—									
Pot 6 ..	203	164·1	49·4	114·7	81·74	36·14	117·88	441 } 437	1,440
Pot 11 ..	203	137·3	49·4	87·9	56·25	35·37	91·62	433 }	1,128
Wheat—									
Federation—									
Summer grown									
Pot 4 ..	137	184·8	26·5	158·3	59·75	39·75	99·50	716 } 678·5	1,794
Pot 12 ..	137	220·2	26·5	193·7	85·50	50·60	136·10	641 }	1,738
Lucerne—									
Hunter River.									
Pot 3 ..	365	499·1	84·5	414·6	..	..	274·6	685 } 684·5	..
Pot 7 ..	365	546·6	83·5	463·1	..	..	307·3	684 }	

The water requirement is expressed as a ratio of the water absorbed by the plant during its growth to the dry matter produced. This ratio is called the Transpiration Ratio.

The results of the tests at Werribee show that winter-grown cereals, even in a drought year, have a comparatively low Transpiration Ratio. The Transpiration Ratio for dry matter shows a fairly close agreement with the duplicate pots, but that for grain shows considerable divergence, mainly owing to the varying percentage of grain and straw.

The Transpiration Ratio, expressed either in terms of dry matter or grain produced, for barley is considerably lower than either wheat or oats.

The Transpiration Ratio for lucerne is, approximately, 75 per cent. higher than that of the average of the three winter-grown cereals.

Summer-grown wheat, with a Transpiration Ratio of 678.5, has a 66 per cent. higher water requirement than the winter-grown wheat of the same variety, notwithstanding the fact that its growing period is 73 days less than winter-grown wheat.

Fig. 3.—A closer view of pot tests showing construction of pots and growth of barley and lucerne in early spring.

As an inch of rain falling on 1 acre is equivalent to 101.28 tons of water per acre, we may express the water requirement of the crops tested in terms of inches of rain for the season 1914:—

Crop.	Inches of Rain required to Produce.		Number of bushels produced per acre for each inch of rain.
	One ton Dry Matter.	One ton Grain.	
Wheat (winter grown)	4·04	10·25	3·63
Wheat (summer grown) ..	6·69	17·34	2·15
Barley (winter grown)	3·33	7·55	5·93
Oats (winter grown)	4·31	12·65	4·42
Lucerne	6·71	..	..

From this table it will be seen that, during the drought year of 1914, winter-grown wheat produced the equivalent of 3.63 bushels of

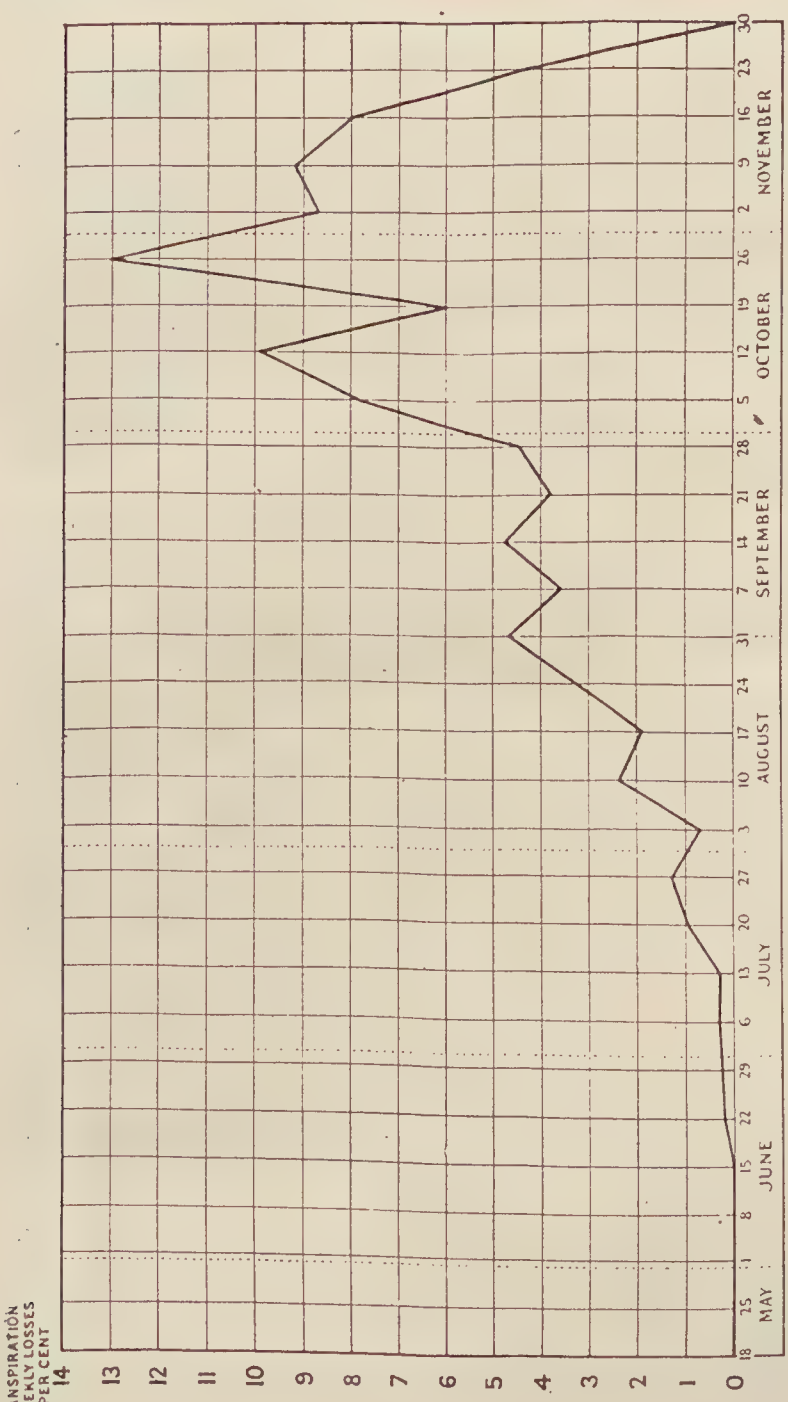


Fig 4.—Amount of water required weekly by a wheat crop throughout its period of growth expressed as percentages of the total water used.

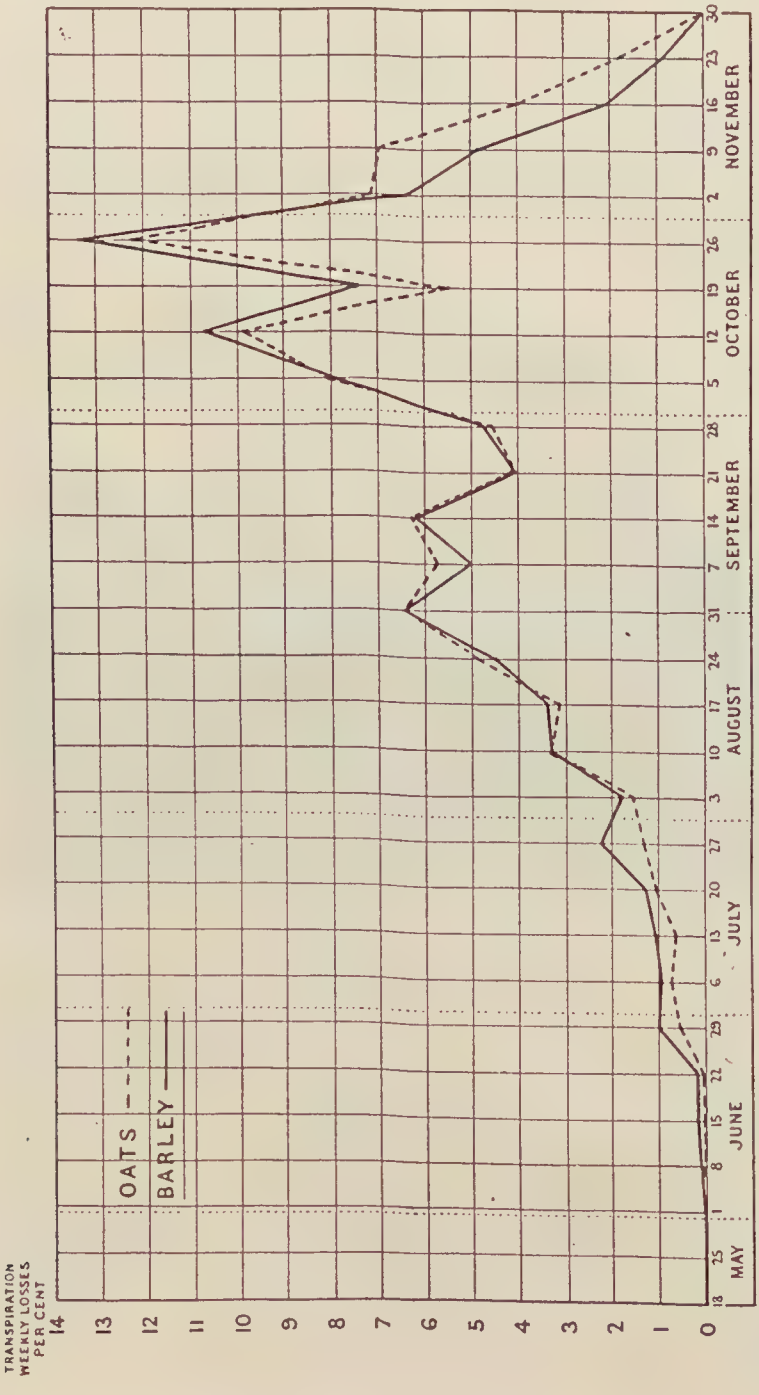


Fig. 5.—Weekly losses by transpiration for Oats and Barley expressed as percentages of total transpiration.

wheat for each inch of rain transpired by the crop. Summer-grown wheat of the same variety produced only 2.15 bushels for each inch received. On the other hand, barley produced grain at less water cost than any other cereal. No less than 5.93 bushels of barley (50 lbs. per bushel) were obtained from each inch of rainfall transpired.

Two other sources of loss occur from crops growing in the field, viz., losses by seepage and losses by evaporation from the soil. The former source of loss may be considerable under irrigation conditions, or in region of heavy rainfall, or when rain falls in heavy showers. In the cereal belt of Victoria losses of this nature are practically nil. The other sourse of loss—evaporation from the soil—may be considerable. It varies with the nature of the soil, condition of the surface crust, amount of shading given by the crop, and with the depth of penetration of the rain, &c. A steady, soaking rain will be more useful than a rain of equal amount spread over many days and followed by strong, drying winds.

We are here concerned only with those losses which occur through the crop, *i.e.*, by transpiration.

The pots in which the crops were grown were weighed weekly throughout the period of growth. A record was, therefore, taken of the transpiration losses throughout the crop-growing period. Such weekly losses, expressed in terms of percentage of the total transpiration, are shown graphically in Figs. 4, 5 and 6.

Figure 4 shows the march of transpiration for winter-grown wheat at Werribee for the season 1914—a typical droughty year. On the whole there was a continuous increase in the rate of transpiration until the third week in October, when 13.04 per cent. of the total water used was transpired in one week. From this stage, there was a rapid decline in the rate of transpiration until 30th November, when the crop matured.

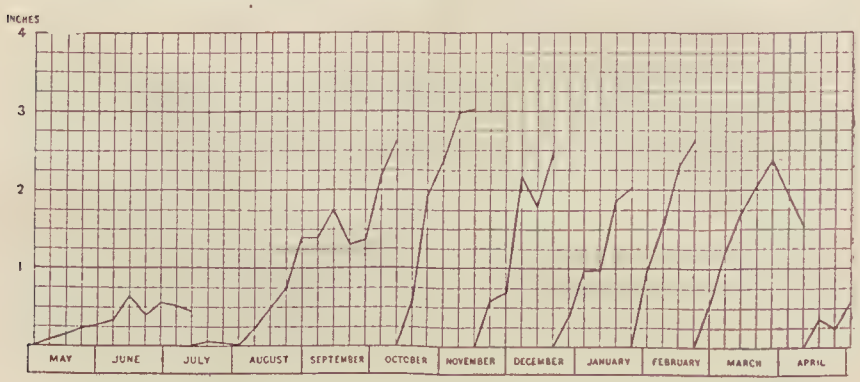
The march of transpiration for oats and barley (Fig. 5) was very similar to that for wheat, except that the percentage of water lost in winter and spring was higher with barley and oats than with wheat. The following table summarizes the transpiration losses each month during the growing period of the crops:—

Table Showing Monthly Losses by Transpiration from Wheat, Oats, and Barley, Expressed as Percentages of the Total Transpiration of the Crop.

Month.	Wheat.	Oats.	Barley.
	%	%	%
May	0·17	0·05	0·22
June	0·78	1·08	1·72
July	2·98	4·51	6·39
August	12·46	18·42	18·39
September	18·45	22·84	22·20
October	41·81	38·35	41·50
November	23·34	14·74	9·56

The period of maximum transpiration for the cereal crops corresponded approximately to the period of flowering. Though the crop-growing period extended over seven months, the amount of water used during the month of October was, approximately, 40 per cent. of the total required for the whole period.

The march of transpiration for a perennial forage crop, such as lucerne, increases continuously, and reaches a maximum near the time of cutting. This is brought out in Fig. 6, which shows the weekly losses of lucerne throughout the year. These weekly transpiration losses have been expressed as inches of irrigation water per acre. Throughout the spring and summer months, the crop of lucerne transpired water at the rate of 2 to 3 acre-inches per week during its period of maximum transpiration. This amount was far in excess of the actual evaporation from a free surface of water for the same period.

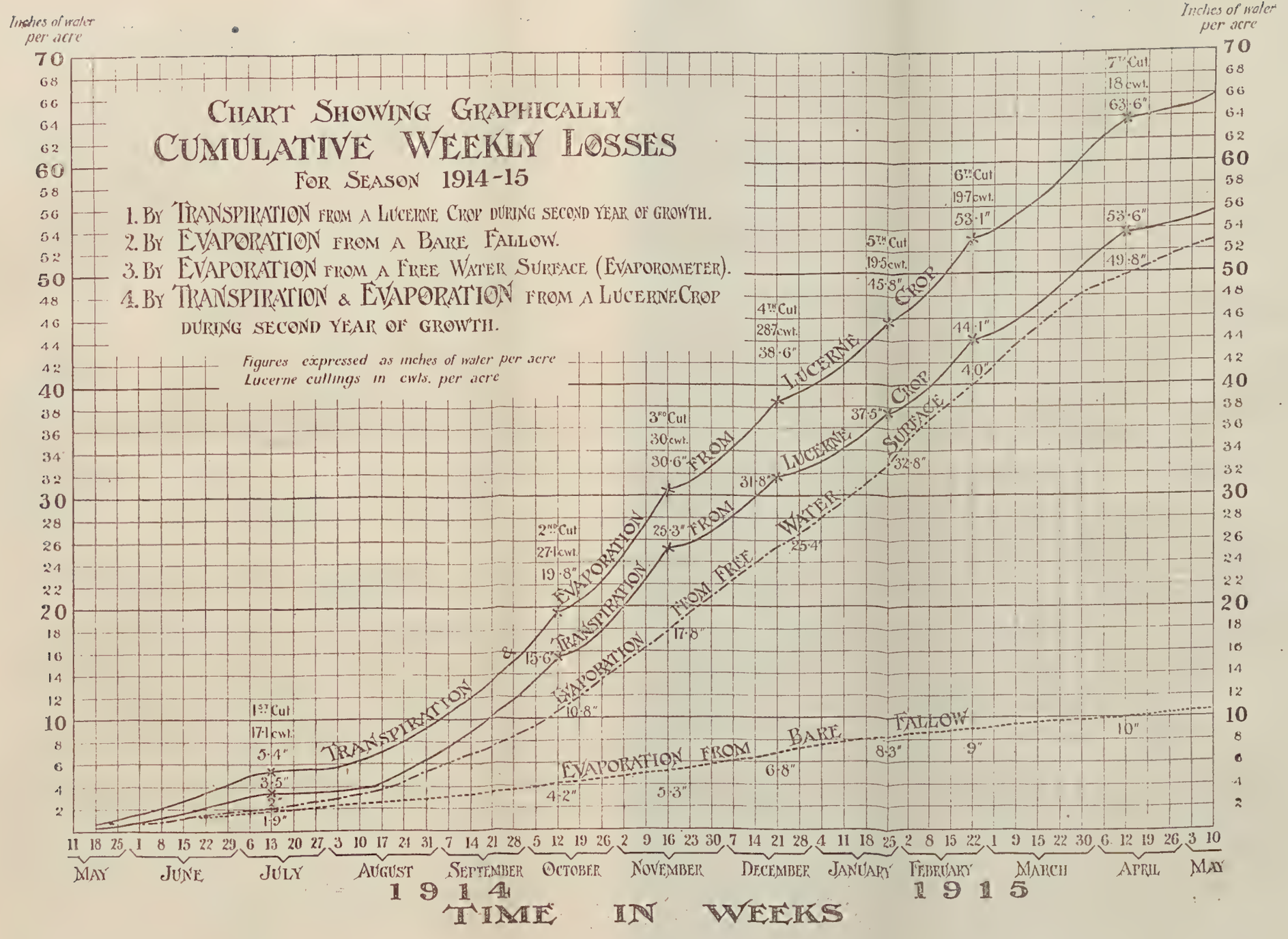


March of Transpiration in Lucerne in Seven Day Periods Expressed as Inches of Water per Acre

Fig 6.

The relationship between the cumulative losses from a lucerne crop, a bare fallow, and the evaporation from a free water surface throughout the year, are shown in the accompanying chart. The losses are expressed as inches of rain per acre, and the yield of lucerne obtained at each cutting is expressed as cwts. per acre of dry matter. Seven cuttings were obtained during the year, and the crop, totalling 160.1 cwts. of dry matter, transpired no less than 53.6 acre-inches of water.

During the same period, the soil in which the crop was grown, though well mulched, lost 10 inches of water by evaporation. The total evaporation from a free water surface for the same period was 49.8 inches. The total losses by evaporation from the soil and transpiration through the crop amounted to 63.6 inches, so that the crop required, approximately, 8 inches of water to produce 1 ton of dry matter, of which, approximately, 6¾ inches passed through the crop, and 1¼ inches was dissipated by evaporation. These results were in close agreement with those obtained from field tests with 15 acres of lucerne.


Inches of water per acre
Inches of water per acre
CHART SHOWING GRAPHICALLY
CUMULATIVE WEEKLY LOSSES
FOR SEASON 1914-15
1. BY TRANSPIRATION FROM A LUCERNE CROP DURING SECOND YEAR OF GROWTH.
2. BY EVAPORATION FROM A BARE FALLOW.
3. BY EVAPORATION FROM A FREE WATER SURFACE (EVAPOROMETER).
4. BY TRANSPIRATION & EVAPORATION FROM A LUCERNE CROP DURING SECOND YEAR OF GROWTH.
Figures expressed as inches of water per acre
Lucerne cuttings in cwts. per acre
1st Cut 17·1 cwt. 5·4"
2nd Cut 27·1 cwt. 19·8"
3rd Cut 30 cwt. 30·6"
4th Cut 28·7 cwt. 38·6"
5th Cut 19·5 cwt. 45·8"
6th Cut 19·7 cwt. 53·1"
7th Cut 18 cwt. 63·6"
TRANSPIRATION
EVAPORATION FROM BARE FALLOW
EVAPORATION FROM FREE WATER SURFACE
LUCERNE CROP
MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY
1914
1915
TIME IN WEEKS

Water Requirements of Crops grown under Field Conditions at Rutherglen, Season 1914-15.

During the season 1914-15, the water requirement of farm crops was determined under field conditions at the Rutherglen Experiment Farm. Five winter-grown crops, viz., wheat, barley, oats, rape, peas, and summer-grown crops, wheat maize, ambercane, and millet, were tested. The pots used were identical with those used at Werribee, and each crop was grown in duplicate, and weighings taken weekly throughout the growing season.

The following table summarizes the results:—

Table Showing Transpiration Ratio for Various Farm Crops Grown at Rutherglen, Season, 1914-15.

Crop.	Water Used.	Water Lost by Evaporation.	Water Transpired.	Dry Matter Produced.			Transpiration Ratio.	
				Straw.	Grain.	Total.	Dry Matter.	
	lbs.	lbs.	lbs.	grams.	grams.	grams.		
Wheat (Federation) ..	158·2	28·75	129·45	72·35	42·04	114·39	514	518
(Winter grown)	162·0	28·75	132·25	73·95	41·0	114·95	522	
Barley (Cape)	154·6	27·65	126·95	75·6	47·0	122·6	466	462·5
(Winter grown)	132·6	27·65	104·95	64·9	37·95	102·85	459	
Oats (Algerian)	187·3	27·65	159·65	81·55	23·38	104·93	685	689·5
(Winter grown)	198·4	27·65	170·75	84·55	26·13	110·68	694	
Peas (Dun)	191·1	25·5	165·6	93·94	51·8	145·12	513	511·5
(Winter grown)	180·0	25·5	154·6	82·86	53·33	136·19	510	
Rape (Essex)	51·3	18·6	32·75	..	..	31·3	470	471·5
(Winter grown)	58·2	18·6	39·6	..	..	37·7	473	
Wheat (Federation) ..	251·4	28·0	223·4	90·5	30·95	121·45	849	876·5
(Summer grown)	242·3	28·0	214·3	81·5	25·92	107·42	904	
Ambercane	188·0	29·6	265·4	..	..	328·5	366	382
(Summer grown)	200·6	29·6	264·8	..	..	301·0	398	
Millet (Hickory King) ..	188·0	24·8	163·2	..	..	166·7	445	459
	200·6	24·8	175·8	..	..	168·2	473	
Maize (Japanese)	245·1	28·3	216·8	..	..	140·5	700	635·5
	244·6	28·3	216·3	..	..	172·5	571	

Of the winter-grown cereals, barley shows the lowest transpiration, both for dry matter and grain. Of the summer-grown crops, ambercane and millet have much lower Transpiration Ratios than maize or wheat. The summer-grown wheat had a Transpiration Ratio 69 per cent. higher than winter-grown wheat of the same variety, notwithstanding that its period of growth was only four months, as compared with seven months for winter-grown wheat.

The water requirement of ambercane, despite the fact that it is a summer-grown crop, is much lower than winter-grown barley, which used water more economically than the other cereals. The duplicate pots show a fairly close agreement, except in the case of maize. The Transpiration Ratios were in all cases higher at Rutherglen than at Werribee. The relative water requirements of wheat, barley, and oats were practically the same at both centres, barley producing dry matter at a lower water cost than either wheat or oats. The same relative difference was observed in the Transpiration Ratio of winter and summer-grown Federation wheat at both centres. At Werribee, summer-grown wheat had a 65 per cent. higher Transpiration Ratio than winter-grown wheat. At Rutherglen, the Transpiration Ratio of summer-grown wheat was 69 per cent. higher than the winter-grown wheat.

Before discussing their difference in detail, we will consider the general effect of climate on transpiration.

Effect of Climate upon Transpiration.

The influence of external conditions upon the transpiration stream has been the subject of a large number of researches since the time of Hales (1748), who was the first to demonstrate that transpiration decreases as the humidity of the air increases. External conditions affect transpiration directly and indirectly, and the effect produced is, therefore, not necessarily the same as it would be in the case of evaporation from a free surface of water.

The more important external factors affecting transpiration are heat, light, humidity, and wind. Heat, light, dryness of air, and wind increase transpiration, whilst cold, darkness, humidity, and a calm atmosphere lessen it.

Temperature has a direct influence upon transpiration just in the same way as it has on evaporation from a free water surface. Moreover, temperature indirectly affects transpiration by influencing the turgidity of the tissues, movement and absorption of water, and width of the stomata.

The visible rays of the spectrum, so far as they are converted into thermal vibrations, must influence transpiration according to the heating effect they produce. Light affects the width of the stomata, and the assimilation of carbon-dioxide accelerates gaseous exchange, and thus favours transpiration. A decrease in humidity increases transpiration, whilst an increase in humidity lessens it. A plant, however, may transpire even in a saturated atmosphere, provided it is warmer than the surrounding air. On the other hand, if the plant is at a lower temperature than the surrounding saturated air, water will be condensed on the plant. Air currents and mechanical vibrations accelerate transpiration, because of the continual removal of water vapour as fast as it is formed. Vibrations of the branches caused by wind favour increased diastomatic transpiration.

Thus it is evident that, in general, transpiration is promoted by the same factors which favour evaporation, though recent studies have shown that the parallel does not hold true in detail. Every cell borders for purposes of respiration upon the inter-cellular air system, which opens to the atmosphere through the stomata. The cells adjacent to the inter-cellular spaces are turgid with water, and this water necessarily evaporates. The air within inter-cellular spaces thus becomes saturated with water vapour, and diffuses through the stomata to the relatively dry atmosphere outside. This is the physical basis for transpiration, and it explains why heat, which is an evaporation accelerator, and dryness and winds, which are diffusion promoters, increase evaporation. Transpiration is essentially evaporation, but when external conditions are such as to favour rapid evaporation from a free water surface, the stomata may close and the rate of transpiration may thereby be decreased. The opening and closing of the stomata regulate the amount of transpiration, and enable the plant to protect itself from wilting. Many plants found growing in an arid environment possess adaptations, *e.g.*, small number of stomata, well developed cuticles, waxy foliage, covering of hairs, thickened leaves, &c., all which tend to limit transpiration. Certain plants, *e.g.*, grain sorghums, reduce transpiration during hot, dry weather by rolling up their leaves.

On the other hand, plants accustomed to the saturated atmosphere of a tropical forest, possess adaptations for furthering transpiration, *e.g.*, special form and arrangement of leaves to aid rapid drainage of water, coloured cell sap, thin permeable cuticles, increased epidermal cells, complete exposure of guard cells.

Finally, apart from the external conditions, and the regulatory activity of the stomata, the rate of transpiration may be reduced, as Burgerstein has shown, by the concentration of the nutrient solution, or by the presence of certain substances in the solution. Thus transpiration is decreased by using a concentrated nutrient solution, or by the addition of small amounts of tartaric, oxalic, nitric, or carbonic

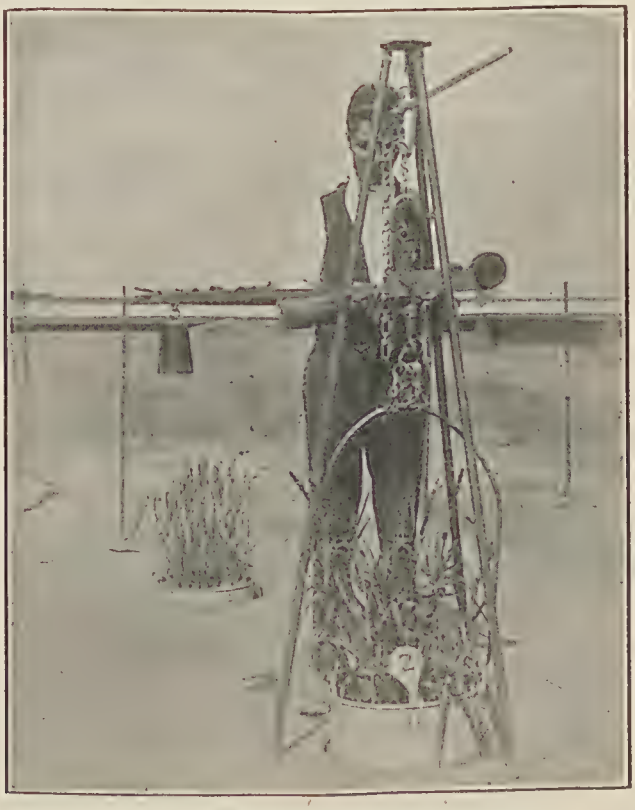


Fig. 7.—Determining the water requirements of farm crops. Method of weighing the pots.

acid, whereas it is increased by alkalies, such as potash, soda, or ammonia, or by the use of dilute nutrient solutions.

Heinrich determined the water requirement of oats in nutrient solutions of five different concentrations. With the exception of the weakest solution, the water requirement decreased as the concentration of the solution increased. The nutrient solution used had the following composition:—4 H_2KPO_4 + Ca Cl_2 + 5 Ca $(NO_3)_2$ + 2 Mg SO_4 + Fe and the concentration ranged from .1 gram to 3 grams per litre.

Transpiration then is affected by (1) atmospheric conditions, (2) the activity of the plant itself, and (3) the nature and concentration of the nutrient medium from which the plant draws its mineral plant food.

The relation of transpiration to climatic factors has been investigated by Fittbogen (1873), Wollny (1877), Hellriegel (1883), Heinrich (1894), King (1905), Leather (1910-11), Kiesselbach (1910), Montgomery and Kiesselbach (1911), Briggs and Shantz (1913-14), Hasselring (1914), Kiesselbach (1916), Briggs and Shantz (1916).

Kiesselbach's researches demonstrated that the rate of water loss from maize was affected in a rather similar manner by changing climatic conditions, as it is from a physical free water surface. The maximum transpiration, as well as maximum evaporation rates, occurred between 1 and 3 p.m. Prior to this time, the increase is gradual from early morning, and following it, the rate gradually recedes until late in the evening. The rate of water loss followed the same general sequence as the diurnal climatic factors. Transpiration was reduced relatively more during the night than was evaporation. This was explained by the fact that the stomata actually closed almost completely at night, and as a result diffusion was reduced.

Transpiration was found to exert a marked reduction in the leaf temperature when the air temperature was high, and as a result exercised a valuable self-protection against water loss.

Briggs and Shantz (1916) determined the correlation between the physical factors of environment and the transpiration of the different crops, and showed that wet bulb depression and evaporation from a shallow tank exhibited the highest correlation with transpiration in all cases.

Comparison of Water Requirements at Rutherglen and Werribee, 1914.

During the season 1914, the Transpiration Ratios for winter cereals at Rutherglen were much higher than the water requirement of the same cereals grown at Werribee. The average water requirement at each centre was as follows:—

	Werribee.	Rutherglen.
Barley	337.5	463
Wheat	409.5	518
Oats	437.5	689
Average of three cereals	394.7	556.7

The average water requirement for Rutherglen cereals in 1914 was, approximately, 44 per cent. higher than that of the same crops grown at Werribee. Werribee is situated a few miles from Port Phillip Bay. Rutherglen is 160 miles inland. A comparison of the meteorological observations at both centres during the growing period of the crop brings out very clearly the greater intensity of the water dissipating agencies at Rutherglen as compared with Werribee.

At both centres, standard instruments were used to determine the evaporation from a free water surface, maximum and minimum air temperatures, wet and dry bulb temperatures and soil temperatures at 1 inch, 6 inches, 12 inches, and 24 inches. The contrast in climatic conditions during the growing period of the crop may be seen from the following summary of the average monthly readings for evaporation,

maximum air temperature, wet bulb depression, and soil temperature at 6 inches:—

Table Showing Rainfall, Evaporation, Maximum Air Temperature, Mean Soil Temperature, and Wet Bulb Depression during Growing Period of Crop at Werribee and Rutherglen, Season 1914.

Month.	Rainfall.		Evaporation.		Maximum Air Temperatures.		Mean Soil Temperature at 6 inches.		Average Temperature at 9 a.m. and Wet Bulb Depression.					
									Werribee.			Rutherglen.		
	Werribee.	Rutherglen.	Werribee.	Rutherglen.	Werribee.	Rutherglen.	Werribee.	Rutherglen.	Dry Bulb.	Wet Bulb.	Depression.	Dry Bulb.	Wet Bulb.	Depression.
	ins.	ins.	ins.	ins.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
June	0·91	0·60	0·99	1·05	59·8	57·2	45·3	46·1	48·4	46·8	1·6	36·5	36·0	0·5
July	0·91	0·88	0·94	1·08	55·8	53·9	44·7	45·0	45·4	43·9	1·5	37·3	36·5	0·8
August ..	0·38	0·46	2·59	1·77	60·7	59·8	50·9	47·5	51·4	49·6	1·8	38·4	37·7	0·7
September ..	1·32	0·47	3·06	3·74	61·1	68·3	54·2	53·8	53·0	49·9	3·1	44·1	42·6	1·5
October ..	0·12	0.00	5·45	7·82	75·1	82·7	61·3	69·2	64·7	60·7	4·0	56·5	51·3	5·2
November ..	1·65	1·06	6·40	9·36	77·4	86·1	65·3	77·9	65·5	62·8	2·7	68·4	61·5	6·9
Monthly Average	0·88	0·58	3·24	4·14	65·0	68·0	53·6	56·6	54·7	52·3	2·4	46·8	44·2	2·6
Average for September, October, and November ..	1·03	0·51	4·97	6·97	71·2	79·0	60·3	67·0	61·1	57·8	3·3	56·3	51·8	4·5
Average for October–November	0·88	0·53	5·92	8·59	76·2	84·4	63·3	73·5	65·1	61·75	3·35	62·45	56·4	6·05

The table shows that, with respect to those physical factors in environment which directly affect transpiration, and which show the closest correlation with it, viz., evaporation, temperature, depression of wet bulb, the average readings for Rutherglen were considerably higher than those at Werribee. The average evaporation, temperature, and wet bulb depression for the growing period of the crop, is, however, not such a useful basis for comparison as the average of these physical factors during the period when the crops approach the stage of maximum transpiration, for, as Briggs and Shantz observed, "the transpiration co-efficient of cereals increases exponentially during the early stages, and reaches a maximum shortly after flowering."

The march of transpiration for wheat expressed in terms of percentages of the total losses, for season 1914, at Werribee, is illustrated graphically in Fig. 4. This graph shows the march of transpiration for a wheat crop expressed as percentages of the total transpiration. The daily losses were very small during May, June, and July, the total loss for these three months being only 3.93 per cent. of the total. They increase rapidly, however, in August and September. During October, wheat, barley, and oats were at their period of maximum transpiration. Of the total water transpired for the season, 41.8 per cent. was required in October for wheat, and no less than 83.6 per cent. during September, October, and November. Hence the averages for the month of maximum transpiration, *i.e.*, October, or for the period September to November, inclusive, are of far greater significance than the mere averages for the growing period. During the month of maximum transpiration, the

average maximum air temperatures was 7.6° F. higher at Rutherglen than at Werribee. The mean soil temperature at 6 inches was 7.9° F. higher, and the average wet bulb depression 1.2° F. greater. The evaporation from a free water surface, which closely approximates a summation of the physical environmental factors, was 7.82 inches at Rutherglen, and 5.45 inches at Werribee, *i.e.*, an increase of 44 per cent. at Rutherglen.

For the whole period September to November, during which approximately 83.6 per cent. of the total water was transpired, the average monthly evaporation was 6.97 inches at Rutherglen, as compared with 4.97 inches at Werribee, *i.e.*, an increase at Rutherglen of 40 per cent.

Thus, while the average transpiration for wheat, barley, and oats showed an increase of 44 per cent. at Rutherglen, as compared with

Fig. 8.—Determination of water requirements of summer forages, Rutherglen. First cutting of Japanese millet.

Werribee, the evaporation during the month of maximum transpiration was 44 per cent. greater, and the average evaporation for the three months, September to November, was 40 per cent. greater at Rutherglen than at Werribee.

From this, we may reasonably infer that the water requirement for cereals in any given season will vary from district to district with the intensity of the physical environmental factors, and that it closely follows the relative intensity of these factors as expressed in the evaporation from a free water surface during the period of maximum transpirational activity. Evidence will be submitted later to show that the water requirement of a given series of crops varies from season to season, and that the seasonal variation in the transpiration ratio is closely related to the evaporation from a water surface during the period of maximum transpiration.

Field Tests at Rutherglen, Season 1915.

The field tests at Rutherglen were repeated in 1915 with the winter-grown crops—wheat, barley, oats, rape, and peas—using the same set of pots as were used the previous year. The season 1915, following on the record drought of 1914, proved to be one of the best seasons for winter-grown crops ever experienced in the State. Wheat crops throughout Victoria grew luxuriantly, and the harvest was a record for the State. The crops in the pots were very luxuriant, as was shown by the large quantities of dry matter and grain harvested from each, as compared with the previous reason. The water requirements, expressed in terms of dry matter, were relatively low, and did not exhibit the striking contrast shown during the previous year. The following table summarizes the results:—

Table Showing Water Requirements of Crops Grown under Field Conditions, Rutherglen Experiment Station, Season 1915-16.

Crop.	Days Growing.	Water Used.	Evaporation from Fallow Pots.	Water Transpired by Crop.	Dry Matter Produced.			Transpiration Ratio.	
					Straw.	Grain.	Total.	Dry Matter.	Grain
		lbs.	lbs.	lbs.	grams.	grams.	grams.		
Barley (Cape)—									
Pot 1	211	310·6	59·6	251·0	300·3	154·1	454·4	251 } 270·5	740
Pot 9	..	393·5	59·6	333·9	322·4	199·6	522·0	290 }	759
Rape (Essex)—									
Pot 2 (two cuts) ..	211	361·9	59·8	302·1	..	..	416·8	328 } 313	..
Pot 8 (two cuts) ..	196	329·7	54·1	275·6	..	..	418·4	298 }	..
Oats (Algerian)—									
Pot 3	211	470·3	59·6	410·7	476·4	168·4	644·6	288 } 294	1,107
Pot 7	211	450·4	59·6	390·8	389·4	200·7	590·1	300 }	884
Wheat (Federation)—									
Pot 5	211	290·7	59·6	231·1	305·8	89·86	395·66	266 } 271·5	1,169
Pot 11	211	316·2	59·6	256·6	334·0	89·90	423·9	275 }	1,295
Peas (Dun)—									
Pot 6	196	292·7	54·2	238·5	277·0	139·5	406·5	266 } 257	77
Pot 10	196	310·0	54·2	255·8	265·5	200·6	466·1	248 }	57

Table showing Comparative Rainfall, Evaporation, Maximum Air Temperatures, Mean Soil Temperatures, and Wet Bulb Depression at Rutherglen, for Growing Period, Seasons 1914-1915.

Months.	Rainfall.		Evaporation.		Maximum Air Temperature.		Mean Soil Temperature, 6 inches.		Average Temperature at 9 a.m.				Wet Bulb.	Depression.
									Dry bulb.		Wet bulb.			
	1914	1915	1914	1915	1914	1915	1914	1915	1914	1915	1914	1915	1914	1915
	ins.	ins.	ins.	ins.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
June	0·60	3·61	1·05	1·17	57·2	53·8	46·1	47·4	36·5	42·4	36·0	41·4	0·5	1·0
July	0·88	1·98	1·08	1·96	53·9	55·1	45·0	47·7	37·3	43·4	36·5	42·5	0·8	0·9
August	0·45	2·91	1·77	1·58	59·8	55·7	47·5	47·1	38·4	44·0	37·7	42·6	0·7	1·4
September ..	0·47	2·37	3·74	2·67	68·3	61·3	53·8	52·3	44·1	48·1	42·6	46·0	1·5	2·1
October	..	2·81	7·28	3·54	82·7	65·6	69·2	56·4	56·5	53·2	51·3	48·6	5·2	4·6
November	1·06	0·18	9·56	6·21	86·1	74·6	77·9	64·2	68·4	57·8	61·5	52·5	6·9	5·3
Monthly average ..	0·58	2·31	4·14	2·85	68·0	61·0	56·6	52·2	46·8	48·1	44·2	45·6	2·6	2·5
Average for September, October and November	0·51	1·79	6·97	4·14	79·0	67·2	67·0	57·6	56·3	53·0	51·8	49·0	4·5	4·0
Average for October–November.. ..	0·53	1·50	8·32	4·87	84·4	70·1	73·5	60·3	62·45	55·5	56·4	50·55	6·05	4·95

The average water requirement for wheat, barley, oats, and peas, for the drought year 1914, was 576, as compared with a requirement of 273 for the same crops grown in 1915, *i.e.*, the Transpiration Ratio for 1914 was double that for 1915.

From the point of view of crop production, no two seasons could have shown greater contrasts. The 1914 season was the severest drought ever experienced in Victoria; the 1915 season, one of the most favorable cereal years, proved to be a year of record wheat production.

The meteorological summary for the growing period at Rutherglen shows the contrast in the seasons very clearly. The mean features of the 1914 season were the uniformly low rainfall (.57 inches per month), low air temperatures in the winter months, and exceedingly high air temperatures during October and November.

The wet bulb depression was small during the winter months, but very great during October and November. The evaporation from a free water surface was low during the winter months, but exceedingly high during October and November. On the other hand, during 1915, the rainfall was liberal and well distributed (2.31 inches per month), the air and soil temperatures showed more uniformity and far less range of variation than in 1914. The maximum air temperatures showed a range of 16.8° F. in 1915, as compared with a range of 31.8° F. in 1914.

Similarly, the range in the average dry-bulb readings for 1914 was 31.9° F., as compared with 15.4° F. in 1915.

Compared with 1914, the wet bulb depression during 1915 was greater during the winter and less during the spring.

Finally, the evaporation from a free water surface during the month of maximum transpiration was only 3.545 inches in 1915, as compared with 7.28 inches in 1914.

In other words, the evaporation during October of 1914 was 121 per cent. greater than in the corresponding month of 1915. For the period September to November, the total evaporation was 20.92 inches in 1914, as compared with 12.43 inches during the corresponding period of 1915.

From these results, it appears that a marked variation exists in the water requirement of cereals grown on the same farm from season to season, due to climatic differences, and that there is a fairly consistent relationship between the seasonal variation in the water requirement and the evaporation from a free water surface during the period of maximum transpiration.

(*To be continued.*)

SUCCESSFUL DAIRY FARMING.

WHAT DOES IT MEAN?

(Continued from page 177.)

By J. M. Kerr, Herd Registrar, Department of Agriculture.

The Homestead Site.

That less travelling may be imposed on the milking cows, it is worth something to have the homestead somewhere near the centre of the farm. A needlessly high position should be avoided, because not only is it a tax on the cows having to climb up to it twice a day, but it also entails a useless increase of haulage in harvesting operations.

Farm Steading.

The dwelling house is a matter for the owner's individual taste, and it hardly comes within our province to advise as to its features, except with regard to its position. It should occupy a more or less higher level than all the other farm buildings. The dwelling should face the farm approach, but it should never be placed too near the line of stable and cow-shed drainage. If practicable the front position should be reserved for it, so as not to necessitate going through the farm yard to reach its front door. But if the only fall is towards the farm approach, then the house is best placed alongside, on the same line of elevation as the farm buildings.

If a home can be given some architectural beauty, not necessarily costly, so much the better, for it is helpful to the occupants to be able to feel constant pride in their home. An unsightly dwelling is not conducive to a man's best efforts, and no doubt contributes to the prevailing tendency of farmer's sons to leave the paternal roof. No farmer, however poor, can afford to dispense entirely with the pleasures of the eye about his home. Mean homes, standing exposed and bare in the landscape, have a depressing effect on even a merely passing traveller; how much more must their effect react on those whose lives are inseparable from such environment.

With all the multifarious duties of a farm always ready to his hand, but ever uncompleted, the farmer too often persuades himself he has no time for such ornamentation as trees and shrubs provide. The mere planting of trees is a small matter—few men fail to do that some time or other; what is more commonly neglected is the longer operation of adequately protecting them from the farm animals, Make-shift guards are of no use, and the farmer who adopts them is right in saying he has not time for such work; they entail planting over and over again, which is pure waste of time. The only way to insure young trees ever reaching a size likely to add arboreal beauty to the home is to make a complete job of the protecting once and for all at the time of planting. And there are but few farms where this is not possible. In shelter rows along the dividing fences, or in well-protected clumps with all sides accessible, trees serve a purpose in keeping the animals warm, which purpose otherwise is served only at the expense of either the milk yield or the fodder consumed.

One need look for no better evidence of the thorough farmer than a wealth of well-placed trees, testimonies of both zeal and industriousness, and, perhaps, also business instinct. It is not suggested that more pressing farm operations should be subordinated to tree planting, but the owner of a treeless home might well give such work preference over the idle and aimless attendance at the local sales, which many indulge in.

The owner should not decide on the site of any building without an eye to the future. The position of any prospective building should be considered in relationship to others already existing, or which will eventually follow, and in relationship, also, to the scheme of drainage. In the interests of sanitation and convenience, the most suitable respective sites for the cow shed, silo, dairy, stable, feed barn, calf pen, manure pit, &c., should all be determined upon by the farmer before he begins to build any of them. He should try to avoid having to place drains where they will need to be frequently crossed by traffic. If this be unavoidable, they should be made strong enough at the crossing to withstand the damaging action of wheels. Later on he will probably add such useful buildings as implement shed, workshop, &c., the positions of which are less material.

The Cow Shed.

The object of a shed to cover the milking operations is mainly to protect those engaged in the work from extremes of weather. There is much to recommend open-air milking out on the grass, if milking could always be confined to favorable weather. But this operation must go on through all weather conditions, be they blizzard or brick-fielder, shower or shine, and the milker is not to be envied who has an ill-designed shed to work in. The design of the building should provide for effective exclusion of rain and strong winds, but the exclusion should only be carried so far as is necessary for the comfort of the workers.

In this climate a shed with its easterly side open has no superior, but this design is not practicable on a large scale. It can always be recommended where not more than a dozen bails are required, beyond that it is better to call a second side into requisition. It adds greatly to the convenience of the work, and often insures cleaner operations, if a bail can be provided for each cow in the herd, but it is not by any means necessary, for, if the floor is as good as it should be, a bail can be used to accommodate several cows in succession without undue fouling. For material there is no need to look further than weatherboard for the walls and galvanized iron for the roof.

The open design of shed, with yard behind the bails which is by far the most common in this State, should always be erected with its open side away from the weather—in northern districts this will mean the south-east, and in southerly districts, almost invariably the east. Thus a southern dairyman is fortunate if he can command an eastern slope for his shed, as this will permit of the most convenient yard arrangement, with drainage flowing away from, rather than towards the bails. A western slope is never so satisfactory, but if no other is available, the best arrangement is to still avail oneself of the natural fall by having the open side in front of the cows instead of behind them. As the cows must in this case be admitted through a wall it entails a door either in the rear or end wall of the shed.

The best arrangement for feeding is to have a feed-storage room along the front of the whole row, and feed the animals from the front. It is a common mistake with open sheds not to extend the roof far enough behind the bails; the benefit of a considerable floor space dry and free from mud has only to be experienced to be appreciated. Six feet is a most satisfactory distance, but certainly not less than four. Much annoyance is obviated by dispensing with supporting posts on the open side, using instead the cantilever principle. It may here be pointed out that it pays to let the roof of all farm buildings project 18 inches or so over the walled sides, thus shielding them from the wet, and effecting a great saving in the painting upkeep; in such case the spouting is attached to the end of the rafters. As convenience ceases when the number of bails in one row exceeds about fifteen, one would be well advised, when more are necessary, to adopt the double row of bails with each row of cows facing away from the other, allowing at least 8 feet between the opposing rear bail-posts. In this case a feed shed will be conveniently placed in front of one row, and the other row may be fed either from a feed gangway in front, or by wheeling a feed truck through the milking shed. If the herd be a large one it is well to have two feed mixing rooms, one in front of each row of cows.

In the interests of sanitation as well as comfort, one should always avoid making the yard on the high side. Neither should it be on the north or west, because the high winds common from these quarters are apt to whirl dry, powdery manure into the milking bails. There are only two aspects which the yard should ever occupy—easterly or southerly—and the whole lay-out of the steading may well be subordinated to this one possibility.

The Bails.

A bail width of 4 ft. 6 in. from centre to centre cannot be faulted for comfort, but in these times of expensive building material is rather a luxury. The commonest width is about 4 feet, and anything less is not recommended. Where leg-roping is practised the length of bail from front to back post should be from 5 to 6 feet, according to the size of the animals to be kept. With cows trained by kindness, leg-roping is rarely required, but, when practised, it should be done in a way that is not uncomfortable to the animal. Therefore the bail in which her neck is placed should not be set towards the left of the stall, but rather nearer the right, thus allowing room for her body against the rail.

The Floor.

Cow-shed floors should always be impervious to water, and for this purpose no floor is more serviceable than one of machine-made bricks, cement-grouted, or one of cement concrete, according to which is most conveniently available. The surface must be smooth for ease of cleaning. The floor in the actual bails should be given a fall of 2 inches from the manger in front to the gutter 6 feet distant at the rear. This gutter, 3 inches deep, and at least the width of a spade, should run along the whole row of bails and be continued outside the shed and on to the manure pit. The gutter should be close behind the cow,

certainly not more distant than 6 feet from the front of the bail. In this position it receives the drainage early, before it has spread over and made slippery a wide surface, which is such a frequent cause of slipping accidents in milking sheds. It is rather an advantage to have the gutter not less than 9 inches wide, as the drainage is not then so likely to be obstructed by dung, and it also facilitates cleaning. No dairyman worth his salt needs to be told that the thorough removal of the manure twice daily is his bounden duty.

Feed Mangers.

If sufficient bails can be provided, the milking shed is the most convenient place for feeding, but the number should be sufficient to permit the cow time to consume all she requires before the necessity to release her. Wooden feed boxes are most commonly used, and if kept cleaned answer all practical purposes. They should be carried up well in front to prevent spillings from the mouth being wasted, and should possess partitions to insure each animal getting its own. Galvanized iron makes a more sanitary manger, especially if hinged on its front edge to permit of its being inverted for cleaning purposes, but in practice, especially if ensilage is used, it is expensive, owing to the corrosive action of this aciduous material on the metal.

Some space should be reserved in every milking-shed for a bench on which the carrying pails may stand out of reach of manure and mud contamination while waiting in the shed to be filled. The milk should not be allowed to remain for any length of time in the atmosphere of the cow shed. If for city supply, it should straightway be carried to the cooling room (which may be constructed similarly to a dairy) and tipped through an effective strainer into a vat from which it is allowed to flow over a cooler through which cool water is flowing to the cooler's full capacity. Where cleanliness is properly understood, muslin or butter cloth can be recommended for straining purposes. Naturally the cooler the water one can command, the more effectively the cooler does its work. Water from a galvanized tank may serve in winter but becomes too warm in summer to be of much use. An underground well gives the best results, but requires to be of good dimensions to remain cool in summer. A good, deep underground tank will enable one to reduce the milk to a temperature of about 65°, or, perhaps, 60°, by the ordinary cooling process on the farm.

Treatment of Cream.

If butter-fat is to be sold it is usually sent from the farm as cream. With this method of disposal, cooling of the milk is not necessary, as the separator skims better with the milk warm as it comes from the udder. If the milk is allowed to become cooler than this it should be heated again to at least 100°, its temperature should be again raised for separating, otherwise valuable butter-fat is likely to escape into the skim milk. This will also occur if the separator handle is turned at less than the specified speed. The fresh cream should never be run into that already on hand, but should be run into a separate vessel standing in cool water, or over one of the specially designed small cream coolers, to cool it down as it comes from the

machine. After the temperature has been thus reduced it may be mixed with the older cream and thoroughly stirred with a well-tinned metal stirrer right to the bottom to insure uniform ripening. Such a stirrer may remain in the can till the can is full. A wooden instrument is not likely to be kept sanitary unless in exceptional hands, and rarely is one found that is not more or less contaminated.

Cream should reach the factory when not more than two days old. In warm weather, daily delivery should be the rule. While on the farm the cream should be kept in a cool dairy, and a clean muslin placed over the vessel to exclude flies while admitting air. The attention necessary for preservation of good quality must commence from the time the milk leaves the udder. Deterioration begins from this moment. In nature this is obviated by the offspring receiving its mother's milk direct from the teat without possibility of intervening contamination. Where any considerable interval must elapse before milk can be used, provision must be made against the rapid increase of germ life which, if not checked, brings about souring and eventual putrefaction. Every man handling a delicate article like milk is better fitted for the work by understanding what it is which brings about the changes which occur in milk after withdrawal from udder.

As a food, milk more nearly approaches perfection than any other single substance. Now there are three things essential to germs, viz., food, warmth, and moisture, and the three are nowhere more suitably associated than in warm milk. Nothing suits the lactic acid bacillus better for food than the natural milk sugar, and the curd of milk is all that putrefactive germs require; in fact, warm milk is their paradise. Once they reach it they require but one thing—a continuance of a favorable temperature—to multiply and multiply unto its eventual total decomposition. The lactic acid germ, feeding on the milk sugar, produces lactic acid which, when it arrives at sufficient quantity, acts as would vinegar, or any other acid to cause curdling. The temperature which these germs mostly enjoy is about blood heat—anything higher or lower steadies their activities. As the rate of deterioration of milk depends on the number and activity of the germs it contains, and as germ development is checked by low temperature, the earlier the cooling is done the better. Cooling the milk is the dairyman's second line of defence only—the first line is cleanliness. Cooling is merely an attempt at checking an evil already present, but cleanliness is in the nature of preventing the access of the evil, which is better.

Although no place is free from dust, and no dust is free from germs of some kind, it is not so much ordinary atmospheric dust which contaminates milk, but rather dirt from the cow herself, the milker's hands, or imperfectly washed utensils. Some few and comparatively harmless germs will invariably gain access from the air of the cleanest cow shed—to exclude them completely is impossible—but the dairyman should realize that every particle of foreign matter which enters the milk, be it from a dirty udder, an unwashed hand, a splash of cow dung, or a common fly, is a source of corruption which had better be dealt with instanter. It may be taken for granted that every particle of dirt entering the milk is germ bearing, and constitutes a focus of infection from which rapid multiplication will immediately begin. Every reasonable effort should be made to prevent access of dirt to

the milk at every stage of the operations. Prior to milking, udders and teats should be at least wiped with a clean, damp cloth that has been washed under a tap and wrung out between each using. Any long hair around the teats should be clipped. The milker should wash his hands (preferably under a tap) before milking each cow. There should be as little as possible contact of milk with the finger. If splashes of manure or dirt from the animal's body or hoofs should foul the bucket, prompt and proper action should be taken to prevent the contamination extending further. Flies should be regarded with abhorrence, and no practicable means neglected to exclude them from the pails. A dairyman with a proper sense of his responsibility will not leave visible impurities for the strainer to remove. The strainer of fine brass wire gauze in which a clean muslin cloth has been inserted is an additional necessary safeguard. But unless used by one understanding the importance of cleanliness, the cloth adjunct may do more harm than good. To clean cloth which has been in contact with milk there should be a first vigorous washing in luke-warm water (not hotter), then wrung out dry as hands can do it, then well soused in boiling water for some minutes, and again well wrung out, and spread to its fullest on a line in clean, airy surroundings to dry. A cloth, especially a damp one, should never be left bunched up after washing. This will defeat the whole object of the cleansing. Poor-keeping quality of milk, cream, butter, and cheese is almost always due to dirty methods in the course of handling. There is no more common cause than unclean utensils; that is, utensils so rust-pitted that they cannot be cleansed, or perhaps utensils in good repair, but which have not been washed as they should be. Neglect to cleanse the separator thoroughly is another frequent cause of trouble. Not to dismantle it and wash the various parts after every using is a hopeless and disgraceful practice. A well-tinned surface on utensils is essential. When the tin has worn so as to expose the iron, the utensil should be discarded, because not only is a rusty surface uncleanable, but iron rust imparts a specific objectionable flavour to the contents.

It is of no use any one imagining a utensil is satisfactorily washed that has not had a final scalding; steam is better still, but no form of severe heat should be applied until all trace of milk has first been removed by the vigorous use of a brush and tepid water only. Every corner and seam must be reached by the brush, so that all adhering matter may be removed, after which the utensil should be allowed to remain for a few minutes in boiling water. Even more effective than boiling water as a sterilizer, if steam under pressure is available, is a small steam pipe coming up through a bench or table, over which the vessel can be inverted and steam admitted for a few minutes. If subjected sufficiently to either boiling water or steam, the utensil will require nothing further than to be inverted on a clean rack, with narrow slats of metal or wood, until again required. Wiping with a cloth after sterilizing is harmful; it serves only to undo the good effect of the heat. If sufficient heat has been applied, the warmth acquired by the metal will disperse all moisture in a few minutes, making wiping altogether uncalled for. The slats of the rack should be narrow to permit free circulation of air within the inverted utensil. Narrow-neck milk cans dry better if, after being placed upside down to drain for a few minutes,

they are again stood upright. Of course, a draining rack should be clean itself and situated in clean airy surroundings. A little washing soda added to the wash water (both the cold and hot) occasionally, will assist to make the cleansing more thorough. Utensils when not in use should always be kept inverted to better exclude dust.

The Dairy.

The dairy should be conveniently situated to the cow shed without being unnecessarily close. After what the effect of cool temperatures on the milk has been shown to be, the object of designing for coolness will be recognised. Whether the dairy is to be used for mere hasty treatment of milk before despatch to market, or for cream storage, or for butter making, it should be designed with the special object of defeating the germ. In fact, all a dairy needs to be is some practical means of protecting dairy products from the changes which the ubiquitous micro-organism is ever ready to work in it. It is again all a matter of cleanliness, for dirt and germs mean the same thing.

The dairy walls and ceiling should be of good height and of smooth surface. The floor should be smooth in surface and of hard material, impervious all over and graded just sufficiently towards the exit (the door opening may be availed of for this) to insure drainage gravitating out to an impervious gutter leading well away to a fenced-in area. Abundant fresh air must be admitted, but all inlet vents should be designed to check its velocity, so that any impurities it bears in the way of dust particles may be precipitated before reaching the inside. The angle at conjunction of walls and floor should be rounded off. Outlet vents should be in the ceiling, and may be straight up through the roof, but inlet vents should take the form of the letter V carried tubularly 2 feet underground before rising to admit the air low down in the wall. The outer tube should be 6 inches above-ground at the entrance, 4 inches in diameter, water-proofed with cement, and capped so to exclude rainfall and flies. Dairies with the floor much below the ground are too difficult of ventilation to be recommended. It is always well to project the roofing well over the walls; this will give shade from sun and protection from damp. Although the dairy must be well lighted, strong sunlight is damaging to dairy produce in more ways than one. Adjustable shutters should be fitted so that any excess of light may be excluded. A white interior is always desirable, and limewash is recommended.

Stable.

The dimensions of this will, of course, depend on the number of horses to be accommodated. It should contain a stall not less than 5 ft. 6 in. wide for each animal. Sufficient room should be allowed behind the stalls to enable the horse to back out comfortably without knocking against the harness which usually occupies pegs specially provided on the wall. While being weather proof in all seasons, the building should also be airy and well lighted. It is an advantage if hinged or otherwise adjustable shutters can be provided for use in times of winter cold and summer heat. The entrance should not be less than 4 feet wide and 7 feet high. A double door is best—the lower

one 4 feet high and the upper one 3 feet, either of which may be opened separately. In summer time additional ventilation may be gained by leaving the upper door open. It is also advisable to have the door on the lee side of the building which, almost invariably, is the east.

As these remarks are intended mainly for dairymen, it is the sanitary aspect of the stabling accommodation which most needs stressing. No stable can be sanitary unless the floor is of suitable material. A floor which cuts up into a puddle or a depression beneath the horse and does not permit of ready escape of liquid drainage, is always objectionable. Although excellent from a purely sanitary aspect, concrete or brick is very hard and cold for a stall floor unless abundant bedding is available. Probably, from an all-round point of view, a good wooden floor, if properly laid, is preferable to either. If well-seasoned sawn 3-inch by 2-inch hardwood be solidly bedded into a well-rammed loam foundation, each piece being tarred with hot coal tar before being tamped and forced closely into place, and laid with a fall of 1 in 50 rearwards, it forms a floor sufficiently sanitary and yet comfortable for the animals. It will be improved by being swept over with hot coal tar, and top dressed with sand. An impervious gutter to which the animal urine will gravitate should be provided along the rear of all the stalls, and given a fall sufficient to quickly convey the liquid outside and well away from the buildings, preferably to a cesspit which, when practicable, should be provided to collect all liquid manure right beside the larger pit for solid manure, over which the liquid can then be regularly distributed, as will be described further on.

Some space must be reserved for feed storage which usually consists of a built-in chaff bin holding several days' food, and a smaller one for oats or bran to cover a similar period.

Calf Pen.

When skim milk is retained on the farm some shelter provision will require to be made for calves or pigs. Not much is required for the former, as they are better out in the open after they are a week old. It is necessary to enclose them when they are removed from the mother, better at some distance, because the bellowing of the calf has a disturbing influence on the dam. While housed calves need a dry, clean floor. They are best in a shed with three sides completely closed to eliminate draughts. The unclosed side may open out into a small run so that the youngsters may frolic at will during fine weather. The calf-run to which they may soon be removed should have good, soft pasture, natural drainage, and protection by trees, a closely-boarded fence or buildings from the coldest weather quarters. If one can subdivide the run into several smaller ones a continuity of the most suitable pastures will be better insured.

Pig Sties.

The pigs' quarters need to be some distance from the dwelling and dairy, &c. It is well to place them, if practicable, below the level of cow shed, or, at least, where their drainage will tend away from the

other buildings. The pigs should never in any circumstances be allowed to roam over the farm yard. Their quarters should be kept clean, and all the manure saved for the growth of fodder crops. These remarks apply equally to fowls.

The Implement Shed.

It is poor policy to leave implements and vehicles out in the sun and rain. A rain-proof roof is all that is required. If a shed on a large scale is required, it is advisable to have access to it from all sides, and also to have the supporting posts strong so that there may be fewer of them to interfere with the moving of the implements.

The Silo.

The only way to insure succulent food the year round is to keep a silo in use. This structure should be placed handy to the cow shed, should be airtight and never less than 25 feet in depth. Its diameter should not be less than 10 feet or more than 18 feet, according to the size of dairy herd to be maintained. It may be of wooden staves throughout, of wood and galvanized iron, of cement-laid bricks, or of concrete. All are satisfactory if properly constructed, the latter two being practically everlasting. A full silo is the best insurance against the occasional dry season which may otherwise so easily catch one unprepared. It should be of adequate strength to resist the internal pressure; its inside surface must be smooth, so as to offer as little resistance as possible to the contents settling. Once well placed in a silo, fodder is safe for an indefinite period, defying both mice and fire.

Manure Storage.

Although in this country farmers generally have not yet come to an adequate appreciation of farm-yard manure, no advice would bear criticism which attempted to justify the prevailing wasteful treatment of it. It is good land, indeed, which farm-yard manure does not improve, and give an increase of value well beyond the cost of application.

To insure its maximum effect it should be used before it becomes stale. It has but a weak hold on its most valuable ingredients and is soon deprived of them, if left exposed to either sun or rain. Its nitrogenous ingredient in the form of carbonate of ammonia is its most valuable constituent, and the farmer who allows its valuable ammonia to float away in the wind day after day is parting with an asset which would cost more to replace than he would care to pay. Access of air is the cause of the ammonia thus escaping, and the way to prevent it doing so is to keep the heap damp. If proper provision is made, there should be nearly sufficient liquid manure to use for this purpose. Liquid and solid manure from the animals should both be conserved, for, if anything, the liquid manure is the more valuable.

All solid manure which can be collected from cow shed and yard stable, pig sty and fowlyard, should be deposited in a pit on a lower level at a sanitary distance yet conveniently situated to cow shed, stable, and sties. If the contour permits of these buildings being built in a

line in that order, it is a good arrangement. An open drain of tiles, brick, or concrete, with sides high enough to exclude surface drainage, should receive the drainage from all three places and discharge into an impervious pit sufficiently large to hold at least two days' liquid drainage. This pit should adjoin the much larger one for solid manure, which should also be of impervious material (a plain clay bottom serves well), and about 2 feet below ground level. Each day as fresh manure is brought down, the liquid manure from the one pit can be dipped out and thrown over the surface of the dung in the contiguous pit, thus dampening the contents sufficiently to retard wasteful decomposition.

Drainage from a manure heap always constitutes a leakage of plant food, one of its virtues for manurial purposes being the solubility of its ingredients. For this reason a roof to exclude the rain is advisable. It should throw the water clear of both pits and be high enough not to interfere with the emptying. The earlier the manure reaches, and is ploughed into the land, the better. It certainly pays to get it out every fortnight, however small the quantity, or else whenever a full drayload has accumulated.

It is foolish for a farmer to be out of a job while there is manure to be distributed. He is no agriculturist who does not appreciate this fact. Any quantity up to forty dray loads to the acre may be applied, but even one-tenth of this will cause conspicuous superiority of plant growth. The loads should be tipped at regular intervals not further apart than twice the distance a man can pitch with a fork. Uniform distribution is most important, otherwise crops will be patchy, and, perhaps, rank where application is excessive. On large farms the mechanical spreader drawn by horses will do the work more effectively, as well as more cheaply, than hand labour.

Subdivision.

In valuing a farm one cannot afford to ignore either the convenience or the condition of the fences. When cropping is practised to the extent that it should be, secure fences are a necessity. The wise dairyman will see to it that his cows are able to obtain a fill without extensive foraging. A cow's digestive apparatus is designed for long pasture, and a full bite of grass is the dairy-cow's right, as long as there is growth. This is not likely to obtain except the farm is divided up into small paddocks which can be spelled in rotation. It is always good practice to give cows frequent changes of pasture, in the interests, not only of the cows, but of the pasture as well.

The root system of any plant is in proportion to its foliage, and prevention of leaf development has a corresponding effect on the roots. If all land were extremely rich, and the rainfall always ample, a very few roots would suffice to serve the plants' needs, but conditions on all farms are removed more or less from this ideal. By leaf development alone are the roots enabled to extend, and the only way to insure this is to give the plants occasional respite from grazing and trampling. The good which the pasture will derive will always be reflected in the animals.

Perfect assimilation of eaten food can occur only in a resting animal. The cow obtaining her fill with a minimum of effort, and

with leisure to digest it, has a great advantage over the animal which has to perform hard labour for every mouthful. One well-known characteristic of a good milking animal—the ability to consume large quantities of feed—is nullified when she has to move her whole body over an excessive area to acquire it. What, under right circumstances, would be a recommendation is turned into a handicap. The daily capacity of a cow's stomach is about 100 pounds of grass. If the pasture is so reduced that 8 acres is required to furnish this amount, a journey of over 20 miles is imposed on the animal. The class of dairy cow one must have to-day should not be condemned to as many chains. If she can obtain a sufficiency in her own length so much the better for the milk yield. As contributors to this end nothing better can be suggested than small paddocks treated with regular dressings of farm-yard manure and lime, or mineral fertilizers.

RICHNESS AND COLOUR IN MILK.

Some researches that have been made indicate that the natural yellow colour in milk, cream, and butter is due to a yellow pigment called "carotin," which appears to pass from the food into the milk, and to be associated with the fat globules. The colour of the milk, therefore, is due primarily to the amount of this substance present in the food, except in so far as certain breeds, notably the Guernsey and the Jersey possess to an exceptional degree the power of extracting carotin from foods and storing it up in their tissues, and are thus enabled to maintain the colour of their milk for a considerable time on diets poor in carotin.

The colouring matter is most abundant in the green parts of the plants, its specific yellow colour being hidden by the green colouring pigment. The following foods are richest in carotin, and, therefore, give milk, cream, and butter of the desired yellow colour:—Green pasture, all forage crops, hay made with the least possible bleaching, carrots and other yellow roots, and new silage. It is notably lacking in hay that has lost its green colour in making, in straw, and in all cakes, meals and offals; also silage appears to lose its carotin in the course of the chemical changes which take place in the silo. There may be some slight differences in the colouring effect of the different cakes and meals, and, according to English Jersey owners, oats and bran will give a paler butter than linseed and cotton cakes, maize and bean meal. Cabbage and other similar plants also give a much better colour than mangolds.

It is a common belief that a yellow colour and a high percentage of fat in milk are necessarily associated. This is usually the case in Jersey and Guernsey milk, but it is not a necessary relationship. Cows of other breeds sometimes give rich milk of a poor colour; all cows give milk of a yellow colour after calving, when the percentage of fat is usually low, and turning out to pasture in spring gives a deeper colour and a decrease in the percentage of fat.—(*The Dairy.*)

DOOKIE CROP AND FALLOW COMPETITION.

Report of Judge, H. A. Mullett, B.Ag.Sc., Chief Field Officer.

The Crop Competition is no new thing at Dookie, but this is the first occasion on which fallows there have also been submitted to the judge. The innovation bears witness to the general interest which is being awakened in the Goulburn Valley in improved methods of cultivation, and in particular to the belief in and around Dookie that possibly the friable soils of the district can be worked under the same system as that practised in the Wimmera. The opportunity was therefore afforded the judge of making, in addition to the inspection of numerous wheat crops, a critical examination of about a dozen fallows representative of the various soil types.

Soils and Climate.

The most striking features of the Dookie landscape are the steep masses of decomposing igneous rock which tower above the town on all sides; that, and the rich colour of the cultivated land, red on the slopes of the hills and black on the flats. The red soil is a free-working clay loam, and the black a rich friable clay loam resembling very much the best Wimmera land; if anything it looks richer and capable of growing even heavier crops than Wimmera soil. The rainfall averages about 21 inches annually. It is therefore ample for wheat growing. In the year just passed the precipitation was much below normal, but certainly not below the quantity upon which heavy crops may be raised. The incidence was such that the autumn and winter were dry. The spring, however, was satisfactory, though short. In all 10.96 inches of rain fell at Dookie for the year. At Salisbury, near Nhill in the Wimmera, slightly less rain was registered—10.07 inches—yet the general average of the crops seen at Salisbury was markedly above those at Dookie. What is the explanation? Possibly the distribution of the rain were more favorable in the Wimmera. The records of the rainfall registered at Messrs. Bennett Bros., Dookie, and Mr. W. E. Dahlenburg's, Salisbury, however, furnish evidence on that point.

	Dookie (Goulburn Valley).	Salisbury (Wimmera).
	in.	in.
January	Nil	.54
February	.97	.10
March	.37	Nil
April	Nil	.25
May	1.11	2.55
June	1.10	1.33
July	1.71	.99
August	1.32	1.08
September	2.89	2.06
October	1.49	1.10
November	Nil	.07
December	Nil	Nil
	10.96	10.07

A Dookie Homestead

Comparing the tables, it is evident that there is little to choose between the seasons in the two districts. Salisbury had good falls in May, but July was a dry month, and it was followed by a dry spring. On the other hand, May at Dookie was somewhat dry, but the spring was fairly good. September in particular was an excellent month. The soils in both districts appear to be equally good. Is it possible, then, that the explanation is in the difference between the cropping methods practised? At Dookie, so far, there is little or no summer-fallowing done, though much of the land lends itself admirably for the purpose. Again, the fallows are not given the same systematic cultivation, though that is on the increase; nor is the cultivation done with the same kind of implements. The quantity of seed used per acre is below that used in the Wimmera, and so is the quantity of fertilizer. Is there not a possibility, at any rate in part, that the yields of the crops in the two districts reflect the differences in method?

Wimmera methods, of course, are not likely to be applicable generally to all types of soil found at Dookie; but there would appear to be little doubt that they will suit the red soils on the hills which flank the township and at Mt. Major and on the associated black flats. But the grey clay loams and the poor rising land need other treatment. The last two types are liable to set down like cement after rain, if cultivated to excess.

The 1922 Competition.

Nine crops, each of 25 acres, and eleven fallows of similar area were submitted to the judge. The crops, after personal inspection, were judged on the scale of points outlined below. Fallows were tested with a spade, and depth of mulch and moisture content, &c., estimated.

RESULTS—BEST WHEAT CROP—25 ACRES.

Mr. P. J. Ryan was awarded 92 marks and first prize for a heavy crop of Major wheat. The yields should be at least 12½ bags to the acre. The 25 acres was the heaviest portion of a paddock of black soil. The crop was dense and regular throughout. It was well headed, but a few strangers were noticed. No weeds were present save an odd saffron thistle. The crop was a remarkably fine one considering the low rainfall. The land upon which it was grown received the following treatment:—Ploughed from 3 to 4 inches deep in June and July; in September spring-toothed and in October skim-ploughed. After harvest the fallow was harrowed following the February rain, disced in March, harrowed in April, spring-toothed in May, and then sown and harrowed. 60 lbs. of seed and 60 lbs. of superposphate were applied per acre.

It will be noticed that the fallow was ploughed fairly shallowly, and early in the season. Subsequently it received thorough cultivation. In particular is the stroke of the harrows after the February rain thought to have played an important part in the yield. As far as possible the working of the land while in a dry condition was avoided.

The crop awarded second prize was 25 acres of Minister grown by Messrs. Bennett Bros.; 86 points were scored. The yield would not apparently be so heavy as the same competitor's Major, but the crop was more true to type and quite free from weeds. The wheat was well-headed, but a trifle thin. It was grown on red land which received the following treatment:—Fallowed in August to from 4 to 4½ inches deep, harrowed three times before harvest, spring-toothed in September and again in October. After harvest it was spring-toothed up and harrowed, and sown about mid-day with 80 lbs. of seed and 106 lbs. of superphosphate per acre.

The Major wheat was sown early in May with 72 lbs. of seed and 106 lbs. of superphosphate. The fallow had been prepared as for the Minister.

The liberal cultivation given the fallow will be noted, as well as the heavy dressing of seed and manure. These are factors which must have contributed to the success of the crop. It is emphasized that the soil on which the crop was grown is red land, while that of the winner is black.

Mr Chas Wolstencroft's paddock of Joffre wheat scored 83 points. The yield was, however, not as high as some other crops; nevertheless, the wheat was very true to type, free from weeds and from any disease whatever. In addition it was short, level and even, though thin. The fallowing was done late—October—and subsequently well worked. The seeding was made in mid-June with 60 lbs. of seed and 90 lbs. of superphosphate.

Mr. R. Fish's paddock of Yanward should yield well. The wheat was fairly pure, but some ball smut was present. A paddock of Joffre shown by the same competitor had been sown early on a black flat. Weeds were bad in the crop, and points were deducted accordingly.

BEST WHEAT CROP—25 ACRES.

Details of Points Awarded.

Competitor.	Variety.	Yield.	Trueness to Type.	Absence of Weeds.	Absence of Disease.	Evenness.	Total.
Possible Points ..	.. .. ..	35	20	15	15	15	100
P. J. Ryan ..	Major	35	17	13	13	14	92
Bennett Bros. ..	Minister ..	26	18	15	14	13	86
Chas. Wolstencroft ..	Joffre	20	19	14	15	15	83
R. Fish	Yanward ..	28	18	12	10	14	82
Bennett Bros. ..	Major	27	16	10	12	14	79
E. Petschack ..	Federation ..	22	14	13	13	14	76
Ludeman Bros. ..	Minister	17	16	15	14	14	76
F. A. Knox ..	Minister ..	23	17	10	11	13	74
R. Fish	Joffre	21	18	5	8	9	61

NOTE.—The points for yield do not represent bushels per acre, but the differences between them do. The winning crop was estimated to yield more than 35 bushels per acre.

RESULTS—FALLOWS.

Mr. J. Knox, of Cosgrove, was awarded 97 points and first place for a fine paddock of summer-fallow on black soil, at Cosgrove. The maximum quantity of moisture had been conserved by careful mulching. The seed-bed was firmly consolidated and moist enough at a depth of a few inches to be moulded with the hand. The mulch, *i.e.*, loose soil on top, was fine in texture and mellow in appearance, and about two and a half inches deep. A point was deducted for somewhat uneven displacement of the top soil, caused by the scarifier ridging slightly. The paddock received treatment as follows:—Ploughed in March to between 5 and 6 inches deep; then scarified in July, again in September, again in August, and again early in November. Each scarifying was made shallowly to a depth just sufficiently to cut weeds, and always while the soil was moist. In summer-fallowing and in the subsequent cultivation Mr. Knox closely adhered to what he had read of Wimmera practice. The scarifier, though not of Wimmera make, did work closely resembling one. In summer-fallowing in the Wimmera it is not the practice to plough so deeply. From 3½ to 4 inches is considered enough. If Mr. Knox will seed this paddock with from 75 to 80 lbs. of seed and 112 lbs. of superposphate late in June, he should harvest a bumper crop.

Messrs. Bennett Bros. No. 1 entry of red fallow was placed second with 92 points. The moisture content was high, though not so good as that of the winner. The cultivation, however, was not so regular throughout. The land was ploughed in August to from 4 to 4½ inches deep, then harrowed, re-harrowed in October, and subsequently a part was spring-toothed.

Messrs. Bennett. Bros. No. 2 entry was summer-fallowed land. The part submitted for inspection, however, was somewhat lower in moisture content than might have been expected.

Ninety-one points were scored by Mr. D. McGuiness for 25 acres of summer-fallow on a black flat 100 acres in extent. The moisture content was good, but the mulch rather rougher than is desirable. The

land was skim-ploughed in February to three inches, skim-ploughed again in August, and then harrowed twice.

Mr. P. J. Ryan's fallow on black soil was also one of those showing good moisture content; the cultivation, however, had not been regularly performed. It was winter-fallowed in July to three inches, harrowed in August and again in December, spring-toothed toward the end of October and then harrowed.

BEST FALLOW—25 ACRES.

Details of Points Awarded.

Competitor.	Soil Type.	Moisture.	Mulch.	Weeds.	Cultivation.	Total.
Possible points ..	.. .. ..	25	25	25	25	100
J. Knox ..	Black clay loam ..	25	24	24	24	97
Bennett Bros. ..	Red loam (No. 1)	22	23	24	23	92
D. McGuiness ..	Black clay loam ..	23	21	24	23	91
P. J. Ryan ..	Black clay loam ..	23	22	24	21	90
Bennett Bros. ..	Black clay loam (No. 2)	21	23	24	22	90
T. J. Ryan ..	Red loam ..	19	24	23	24	90
F. Petschack ..	Sandy loam ..	21	24	23	21	89
J. Panter ..	Silty loam ..	20	23	23	22	88
Bennett Bros. ..	Red loam (No. 3)	20	20	23	23	86
J. Cummins ..	Loam	20	20	22	22	84
F. A. Knox ..	Red loam ..	18	19	23	20	80

New Methods for Dookie.

To those who know the Wimmera, the prices asked for the rich black flats at Dookie appear to be surprisingly low. Land similarly situated and of much the same appearance would command nearly double the price in the Wimmera. What is the explanation? The answer is that the yield per acre is higher in the Wimmera.

A question that any Dookie farmers who have black land are asking themselves is, would the adoption of Wimmera practices result in improved crop yields? The answer is that there does not seem any reason why it should not. But, of course, the proof of the pudding is in the eating. No one will know until a trial has been made. Already, go-ahead farmers like Mr. J. Knox and others are attempting to put it to a practical test. Next year the competition should afford an opportunity for comparison of crops grown on land treated in the Wimmera way with crops grown on land treated the Dookie way. But the Wimmera method involves the use of the Wimmera scarifiers in place of the skim-plough So far there are only one or two implements of the type mentioned in the district.

Cropping Black Land.

Friable black soils of the type found in the Wimmera and at Dookie have certain characteristics in common. They are very sticky while wet, they naturally grow a rank crop of weeds and wild oats, and often it is difficult to get the seed-bed thoroughly consolidated, conditions

which practical men know go hand in hand with "take all." In the Wimmera these difficulties are overcome by the use of well-designed implements, and by fallowing according to a special method. The black land is usually best ploughed shallowly, that is to from 3½ to 4½ inches deep with a prong mouldboard plough. This does not stick up so badly as the ordinary mouldboards which of course are never "clean." Preferably the original ploughing is done in February, March or April, while the land is dry. In this condition the going is easy, and excellent work can be done. This is called summer-fallowing. The shallow ploughing permits of more effective consolidation. Weeds will germinate well and grow vigorously on the summer fallow. They must be "sheeped" down, or else it may be necessary to replough the paddock. In July the paddock should be scarified to a depth of about 3 inches. Any winter-fallowed land is ploughed at this time to 3½ to 4 inches deep.

Spring-toothing the fallow—Messrs. Bennett Bros., Dookie.

As a rule, the fallows of both types may be treated alike afterwards. The harrows follow, and then as weeds make vigorous growth, the scarifier in September and possibly again in October is used. Each stroke should be followed with the harrows, and the September scarifying should cut to a depth of only about 2½ inches so that a firm bottom is left. On no account should the scarifier be permitted to tear into the bottom. As far as possible each cultivation should be across the direction of the last. Later on, whenever rain falls, the paddock should be harrowed, if other duties permit. No work, other than the original summer-fallowing, should be done while the land is dry and dusty.

In the autumn the rubbish is scarified and the paddock harrowed; this is followed by a further scarifying of rubbish and harrowing before the drill. In this way some eight to fourteen or fifteen workings may be given the land. The effect is to clean the soil of weeds, to liberate the maximum supplies of plant food, and to consolidate the seed bed thoroughly.

Land of this class grows rank dirty crops if sown early. It would be worth while testing portion of a fallow prepared as outlined above with a late-sown crop—say July-sown. Black soil can hardly be put in too wet, so there is little to fear from a germination point of view if this course is adopted. If 75 lbs. of seed are used, with 112 lbs. superphosphate per acre, the crop will be short and clean and should yield heavily.

For the red land, though not nearly so sticky, somewhat similar treatment should suffice, though it may be sown earlier.

Treatment for the more refractory soils of the district has been exhaustively dealt with in the report furnished to the Shepparton Agricultural Society.

WEEDS AND THEIR ERADICATION.

(Continued from p. 189.)

By H. W. Davey, F.E.S., Orchard Supervision Branch, Department of Agriculture.

Stinking Sheep Weed, *Gilia squarrosa,* H. and A. Family: *Polemoniaceæ.*

This evil-smelling annual (Fig. 59) belongs to the Phlox family. It is a low-growing plant, usually under a foot in height, but sometimes reaching even 2 feet. About twenty species of the genus Gilia have been described. All are natives of America, where some of them are cultivated as garden plants. The species *squarrosa* first came into prominence here some twenty-one years ago.

As a rule it consists of several many-branched stems with alternate leaves; these are pinnatifid (cut into lobes nearly half-way to the midrib) and the segments are deeply incised and furnished with pricking points, the latter making it a most unpleasant weed to handle, especially after it has become dry.

Stinking Gilia has small, pale-blue flowers contained in dense heads of a burr-like appearance. The entire plant is covered with hairs, and is sticky-glandular. On account of its fetid odour, it has received several names indicative of its character, as, for instance, Skunkweed, and Stinkweed.

Stock will not eat it, and if it be harvested with hay it will spoil the hay by imparting to it an offensive flavour. This led to its being proclaimed a noxious weed throughout the whole State.

The best method of control is either to hoe the plants before they have seeded or to keep them cut frequently during the growing season.

The seeds of the Gilia are said to be short lived.

Merian's Bugle Lily, *Watsonia Meriana,* Mill. Family: *Iridaceæ.*

In the *Victorian Naturalist* 1907, Vol. XXIV., page 15, Professor Ewart gives a list of "Unrecorded Introduced Plants," among which this Watsonia is listed as a garden escape and rapidly establishing itself in the Mornington District. Since that was written it has established itself over very large areas of land.

Fig. 59.—Spray of Stinking Sheep Weed, *Gilia squarrosa*, H .and A. (Natural size.)

The plant (Figs. 60 and 61) can easily be recognised by its stiff broad leaves, its globular corm, and where land is heavily infested, its rose-red blossoms become during the flowering season a very distinctive feature of the landscape.

Fig 60.—Merian's Bugle Lily, *Watsonia Meriana*, Mill.

It is a perennial bulbous plant, and is a native of South Africa, and affords another instance of the geniality of our climate in favoring the spread of alien weeds.

This Watsonia favours land that is very moist during the spring months, and in such situations will take entire possession of the ground

to the exclusion of other vegetation. As it cannot be hand-pulled on account of its firm grip of the soil, the plants should be dug or mattocked out before they flower, and then collected and burnt. Cultivations should be frequent, so as to bring the corms to the surface, and thus

Fig. 61.—Merian's Bugle Lily—flower and bulbils on stems.

dry out those that have started into growth. It may take some years to rid the ground entirely of this pest.

Merian's Bugle Lily is proclaimed a weed throughout the whole State of Victoria.

(To be continued.)

EXPERIMENTS IN THE STORAGE OF FRUITS.

(Continued from page 186.)

By D. B. Adam, B. Ag. Sc., Department of Agriculture.

APPLES.

It will be convenient to consider the question of the storage of apples in a manner similar to that used when the question of pear storage was discussed. (*Journal of Agriculture,* March, 1923.) There it was

Apple Scald.

Samples of different varieties after exposure in a container to malonic ester vapour.

shown pears were limited in their storage life by two types of condition arising. These were:—(1) Physiological disturbances, where the cause is inherent in the fruit itself, when it is under particular conditions of storage; (2) mould decay, where the cause is a definite isolable organism of a fungal character.

The skin blemishes, scald and Jonathan spot, and flesh collapse are examples of physiological disturbances in apples.

The development of scald in cool storage will be considered first.

After long storage, scald is easily the most serious defect in many varieties of apples. The first sign of the disease is recognised by a brown coloration of the surface cells in characteristic, sharply defined areas. This affection, at first quite shallow, extends into the underlying tissues, and may, in time, involve the whole of the apple. The different varieties of apples vary in their susceptibility to scald; the character of the injury produced also varies in the different varieties.

Scald develops rapidly on the removal of affected fruit from store.

Experimental results will be given, and an interpretation of these will be sought. Special attention has, as a result of the experiments outlined below, been directed to the theory of Brooks, Cooley, and Fisher.*

Experiments with Rome Beauty Apples.

In the table given below the fruit referred to was examined after nine months' storage, the examination taking place immediately after its removal from store.

Table I. shows the effect of aeration and temperature on the development of scald in immature (see Note (*a*)) Rome Beauty apples from Drouin. The fruit was packed in bushel cases, the sides of which were lined with paper; the fruit was not wrapped.

Table I.

Chamber No.	Temp. Deg. F.	Refrig. System.	No. Apples Showing—		No. Sound.	Per-centage Sound.	Grade, &c.
			Slight Scald.	Bad Scald.			
1	32	Direct Expansion and Air Circulation	16	38	90	67	3″
2	32	Direct Expansion ..	10	34	90	67	3″
26	32	Air Circulation	4	32	56	62	3″ (See Note (*b*))
3	34	Direct Expansion ..	18	33	14	22	3″
5	34	Direct Expansion and Air Circulation	0	1	59	98	3″ (See Note (*c*))
6	37	Direct Expansion and Air Circulation	11	20	18	36	3½″
7	37	Direct Expansion ..	0	15	42	73	3″
8	37	Air Circulation ..	5	17	21	49	3½″ (See Note (*d*))

Note (*a*).—The maturity of any fruit is a quality that it is difficult to describe accurately. In the present instance the fruit was green, quite devoid of "colour"; the flesh was slightly greenish colour, and distinctly acid to the taste.

(*b*) Chamber No. 26 is a commercial chamber. Here, though the temperature is 32° F., the volume of air passing per cubic foot

* *Jour. Agr. Res.*, Vol. XVI., p. 195, vol. XVIII., p. 211.

of storage space necessary to maintain this temperature is not nearly as great as it would be if the chamber were of the dimensions of the experimental series.

(*c*) This fruit was placed immediately underneath the inlet duct, cold air at 30-32° F. passing directly through the case of fruit.

(*d*) Owing to the comparatively high temperature of this chamber, there is practically no cold air passing through it during the winter months.

Whilst these results are not entirely uniform, they demonstrate that—

(1) Immature fruit is susceptible to scald.

(2) Scald is more severe at higher temperatures than at low temperatures.

(3) Efficient ventilation practically eliminates scald. (Note excellent results obtained in Chamber 5.)

(4) When the conditions favouring scald production are pronounced, as in the case given, the circulation necessary to cool the chambers in the air circulating system chambers has little effect on scald development (see later tables—Rymers).

Some Rome Beauty apples off thirty-year-old trees, from Beechworth (a warm district) did not show any trace of scald when stored under the different conditions of refrigeration and temperatures that were used. These apples were well coloured, and would be classed as mature; the ground colour was light green, the flesh had just a tinge of greenness, and the seeds were dark brown. Another consignment of Rome Beauty apples from Geelong (a cooler district) was also practically free from scald. For the variety, Rome Beauty, the apples were of medium to poor colour, though in respect to taste, colour of flesh and seeds, would have been classed as mature.

These results show the one variety—Rome Beauty—varying considerably in its susceptibility, and this susceptibility is proportional to its maturity.

Experiments with Rymer Apples.

The results from the storage of Rymer apples, grown at Harcourt and Ringwood respectively have been compared. These results are given below in Table II. (*a*) Harcourt fruit; (*b*) Ringwood fruit.

TABLE II.

Chamber.	Refrig. System.	Sound.	Scald.	Scald.	Grade.
				Per cent.	
No. 1	Direct Expansion and Air Circulation—				
	(*a*)	62	38	38	3″
	(*b*)	187	1	1	2½″
No. 2	Direct Expansion—				
	(*a*)	49	48	50	3″
	(*b*)	102	7	7	2¾″
No. 26	Air Circulation—				
	(*a*)	38	90	70	2¼″
	(*b*)	63	31	34	2¼″

As previously noted, chamber No. 26 is a commercial size chamber where the amount of the circulation cannot be compared with that in the chambers of the experimental series. Both samples of apples were picked off old trees. The Harcourt lot was not wrapped, and was forwarded on the 4th April; that from Ringwood was wrapped, and forwarded on the 25th April.

The results again show the importance of maturity in scald development. From the extent of the injury in the Ringwood fruit, which was small, and the percentage affected, it has been assumed that the conditions for scald development are less favorable here than in the instance of the Rome Beauty apples previously referred to. A comparison of the results obtained in chambers 1 and 2 shows the alleviating effect of good circulation on scald development. On the other hand, the large "air circulation chamber" gives consistently poor results. It, however, would be useless to compare results from this chamber with those of the experimental series, when the problem is apparently dependent rather on relative air movements than on actual temperature. Again, it is clear that where the conditions for scald development are favorable, the amount of circulation that the engineer has control of has little effect on scald development. This statement, of course, refers to the chamber as a whole, and not to any special position such as immediately under the discharge duct.

Another case of Rymers from Drouin showed 70 per cent. scald when stored at 32° F. In examining these apples, it was noted that the slightly "coloured" apples were the most severely scalded. Apples which were quite green showed a much smaller percentage of scald, whilst the fully matured apples were most subject to it. Brooks, Cooley, and Fisher were the first to observe the greater freedom of immature apples from scald as compared with mature fruit (*loc. cit.*).

Experiments with Winter Majetin and Stone Pippin Apples.

Some Winter Majetin apples stored at 32° F. were very badly scalded after five months' storage. This fruit was packed in the standard "dump" bushel case, the inside of which was lined with a double layer of newspaper. The fruit was not wrapped. These apples, from trees thirty-four years old, were leaf-green in colour, though classed as fairly mature by the grower. The scald was equally bad under each system of refrigeration. The odour of apples, generally considered to be due to a mixture of esters exhaled by the fruit, was very strong.

Stone Pippin apples are well known to "brown" after a period in storage—generally in the months of October and November. If removed from store to a warmer place, they rapidly develop typical scald injury.

Several samples of Stone Pippins from Pakenham, Harcourt, and elsewhere, stored in different chambers under commercial conditions, as well as in the experimental chambers, developed scald on removal from store during the first week in November. Here also there was a very distinct apple odour.

Neither the scald injury nor the apple odour was as pronounced as in the cases of Winter Majetin apples.

Experiments with Jonathans.

The use of tissue papers, soaked in odourless and tasteless mineral oil, as a wrapping-paper has been recommended by American workers for the prevention of scald.

The Jonathan apple is notorious as the most susceptible variety of apple to scald. Several consignments of Jonathans were received from different districts. Some of each of these lots were wrapped in oiled papers; none was scalded. However, as no more than 1 or 2 per cent. were scalded in any one case, the results are inconclusive. In explanation it may be noted that as the experiments were not commenced until the Jonathan season was nearly over, all such apples received were naturally quite mature, and, as shown before, mature apples are not so liable to scald as immature ones.

Cause of Scald.

Many theories have been advanced as to the cause of scald in apples. Some local current ideas may be quoted:—"Too low a temperature"; "too sudden cooling"; "cold air blowing on the fruit"; "too high humidity"; "excess of carbon dioxide," &c. Each of these theories, except the last one, which was not tested, have failed to explain fully the facts of the experiment as presented.

Brooks and his collaborators consider that scald is produced by gases other than carbon dioxide exhaled by the fruit. These gases are of the nature of a mixture of esters. A form of scald of a similar appearance to cold storage scald may be produced by placing the fruit in a closed container with the ester amyl acetate. A similar experiment by the writer using ethyl malonate, or malonic ester, resulted in the production of typical scald injury on a large number of varieties. (See illustration on page 234.)

In examining these artificially scalded apples, it was noticed that the maturer samples were scalded worse than the less mature samples. The varieties themselves also varied greatly in their resistance to scald injury. After six days' exposure to the air, Granny Smith, Dunn's, and Yappeen seedling apples did not show any sign of scald, whereas Jonathan, Five Crown, and Rome Beauty apples, held in the same vessel at the same time, where badly scalded. These resistances compare very favorably with results in scald incidence obtained in cool storage practice.

Again, the character of the scald injury is dependent on the variety of the apple. Apples, it is known, vary in the quality or texture of their flesh, some being known as soft varieties, for example, the Jonathan; others as hard varieties, *e.g.*, Stone Pippin. Considering both this fact and the nature of the probable causal agent, we may expect, for various reasons, that the form of injury would vary with these varieties. The differences are found, in actual practice, both with natural and artificially scalded apples. Scald injury in a Jonathan apple is at first quite "shallow," but soon develops—extending into the

flesh, producing slightly sunken areas. The depth to which it penetrates, of course, varies according to the time when it is examined. In Stone Pippin apples, on the other hand, penetration only extends up to about $\frac{1}{8}$ of an inch, even after long periods of storage. The affected areas do not sink appreciably. Such varieties, when first examined, have a brown mark on the skin, which is quite firm, and only "skin deep."

These experiments are merely preliminary in nature, but do indicate lines for future work, particularly the nature and quantitative relations of the gases exhaled during ripening. More extensive experiments in the use of oiled papers are also required. This mode of limiting the losses from scald seems to be more desirable than an attempt to control circulation in actual practice—especially when the conditions for scald production are favorable.

Jonathan Spot.

This disease is so named on account of its nature, and frequent occurrence on Jonathan apples—particularly after they have been in cool store for some time. It should not be confounded with Bitter Pit, from which it is quite distinct. In appearance, the diseased areas are circular brown patches from $\frac{1}{8}$ to $\frac{1}{4}$ of an inch in diameter; the surface colour-bearing cells are affected. In the centre of each affected area is a darker portion, the lenticel, from which the disease seems to have spread. At times, the spotting acquires a form peculiarly like a bacterial infection, the area immediately around the lenticel remains green, being surrounded with a more or less regular brown ring. The affected areas of cells collapse. Gases like ammonia and formaldehyde will also produce injury on apples of a similar appearance to Jonathan Spot (Norton).*

No organisms have as yet been definitely associated with Jonathan Spot. A species of alternaria has been isolated from a varying number of spots by Cook and Martin.† The presence of this fungus, however, is possibly the result of an after infection. Jonathan Spot also occurs on the variety Scarlet Non Pariel. Indeed, with the apples used in the experiment, Scarlet Non Pariel apples were worse affected than the Jonathans. The disease is also found on the Rome Beauty, though there to a much more limited extent.

Jonathan Spot varies in its incidence with the different stages of maturity of the apple. The conditions favouring spot development appear to be different from those favouring development of scald.

A comparison has been made between the respective development of spot on Jonathan apples stored at 32° F. under two different systems of refrigeration. The apples were grown in different districts, and were of different maturity. The maturity was estimated by the average general tone of the green ground colour and the colour of the flesh. In the table given hereunder, the consignments are arranged in descending order of maturity. The lot from Ringwood, though the least mature of those considered, was certainly not immature. With the exception of the Harcourt consignment, where there was a negligible

* Phytopath III., 1913, p. 99.
† Phytopath IV., 1914, p. 102.

amount of scald (3 per cent.), no scald developed on any of the apples. The results are set out in Table III.:—

Table III.

Chamber.	Refrig. System.	Sound.	Slightly Spotted.	Badly Spotted.	Spot.	Remarks.
1	Direct Expansion and Air Circulation—				Per cent.	
	(*a*)	91	13	2	9	Harcourt, well coloured
	(*b*)	122	52	7	21	Drouin, medium colour
	(*c*)	149	20	7	10	Drouin, medium to good colour
	(*d*)	185	23	0	6	Ringwood, good colour
2	Direct Expansion—					
	(*a*)	53	42	13	40	See Note (*a*) page 235
	(*b*)	84	24	4	16	See Note (*b*) page 235
	(*c*)	185	17	8	8	See Note (*c*) page 236
	(*d*)	172	1	4	3	See Note (*d*) page 236

N.B.—The percentage of spot is a calculation of the ratio of "badly spotted" to sound apples. For this purpose, two "slightly spotted" apples have been considered as equivalent to one "badly spotted" apple. A "slightly spotted apple" has four or less spots.

The nature and mode of estimating the extent of spot has possibly given rise to the irregular results given above. These results, however, demonstrate a correlation between maturity and spot development. The mature apples were spotted worse than the less mature.

Table IV. gives a comparison between the percentages of Spot on Jonathan apples stored under different conditions of temperature and refrigeration.

The apples are the same samples as referred to in Table III.—Drouin (*a*) and Ringwood.

Table IV.

Chamber No.	Temp.	Refrigeration.	Drouin.	Ringwood.
1	32° F.	Direct Expansion and Air Circulation ..	10	2
2	32° ,,	Direct Expansion	8	3
3	34° ,,	Direct Expansion	5	10
4	34° ,,	Air Circulation	18	1
5	34° ,,	Direct Expansion and Air Circulation ..	14	No figures

From these results there appears to be no apparent connexion between—

(*a*) Temperature;

(*b*) The refrigeration system;

and the development of the Jonathan Spot.

Two consignments of Rome Beauty apples were received from Drouin—the first (*a*) on 13th April, 1922; the second (*b*) on 4th May, 1922, three weeks later.

The results of the comparison of these consignments is given in Table V.:—

Table V.

Chamber.	Refrig. System.	Temp.	Spotted.	Not Spotted.	Spotted.
					per cent.
No. 4 (*a*)	Air Circulation	34° F.	0	75	0
No. 4 (*b*)	Air Circulation	34°	30	126	20

Neither consignment was scalded.

The results show a close relation between maturity and Spot development.

Some Scarlet Non Pariel apples, on examination in November, were found to be badly spotted. Stored at 32° F. in chambers 1 and 2, they showed from 50 to 90 per cent. Spot. These apples were fully matured, grown at Beechworth, forwarded and placed in store on 26th April, 1922.

The Cause of Jonathan Spot.

No specific cause for the development of Jonathan Spot can be cited. Attempts to isolate fungi on various culture media have not been successful. Its occurrence to a fairly uniform extent under the different systems of refrigeration employed does not agree with the theory that ammonia is a causal agent, since in some of the systems employed the presence of ammonia even in traces is practically impossible. Its relation to maturity has, however, an important practical bearing. The orchardist must study maturity closely. If he picks too early scald develops; if he allows the fruit to remain too long on the trees, Spot will develop in store. While Jonathan Spot is the lesser of two evils, it has been shown that if an apple is picked at a particular stage in its maturity, neither scald nor Spot will develop appreciably.

(*To be continued.*)

CUTTING OF CALIFORNIAN THISTLE.

In view of certain statements that Californian thistle is checked far more effectively when cut in flower than is the case with earlier cutting, the New Zealand Department of Agriculture recently carried out tests on selected areas in Canterbury. Cutting at the respective stages was done last season, and the results, after the lapse of a year, have now been duly observed and recorded. Neither area gives any indication that late cutting results in the reduction of the thistles, there being no apparent difference between the late and early cut patches. Taking everything into consideration, including the obvious risk of allowing the thistle to flower, the Department cannot indorse the method of late cutting.—*New Zealand Journal of Agriculture, March,* 1923.

DISEASES OF THE COTTON PLANT.

By C. C. Brittlebank, Plant Pathologist, and D. B. Adam, B. Ag. Sc.

The cotton plant, *Gossypium* sp., is liable to a variety of serious diseases. Some are caused by fungi, the spores of which are carried on the lint remaining on the seed after ginning. Black rot or cotton wilt, caused by the fungus, *Fusarium vasinfectum* E.F.S., and Anthracnose of the boll and stem, caused by the fungus, *Glomerella gossypii* (Southworth) Edg., are examples of two serious diseases which are spread by this method.

Neither of these diseases has been reported as occurring in Australia. There, however, is a possibility of their being found in Queensland, where cotton has been grown for about fifty years. As no effort to prevent the introduction of disease in the original seed samples was made, that State must be considered a possible source of infection. All seed brought from there should, therefore, be subjected to the same disinfection and treatment as any imported from overseas. On account of the dryness of the adhering lint, it is difficult to effectively soak the usual sample of cotton seed in any disinfectant. It is necessary to remove the lint. The concentrated sulphuric acid method of treatment is an efficient and cheap way of delinting cotton seed. (J. F. Duggar, Alabama, Expr. Sta. Rec. XXV. 2 p. 132.) The seed is placed in a wooden or earthenware vessel, and then covered with commercial sulphuric acid for from ten to fifteen minutes, being stirred constantly with a wooden ladle. The seed can be removed in an earthenware vessel with a sieve bottom. The sulphuric acid may be used for treating several lots of seeds. The treated seed is washed in running water for twenty minutes, and allowed to drain. For complete disinfection, the seeds may then be placed in corrosive sublimate (1-1000) for fifteen minutes, and at the end of that time allowed to dry.

Experiments in the use of this process have been made in the laboratory of the Department of Agriculture. Some have been designed to test the effect of the treatment on the germination of the seed and the condition of the young plants. Other experiments have been carried out to test the effect of immersion in sulphuric acid for varying periods:—

(1) The Effect on Germination.

Two samples of 100 seeds each were taken. One was treated for fifteen minutes with sulphuric acid and then washed for twenty minutes and germinated. The other sample was not treated. Of the treated seed 88 per cent. has germinated in three days, and in four days 93 per cent., which was the total germination. The growth was clean and vigorous. Of the untreated seed 86 per cent. germinated in four days and 90 per cent. in six days, which also was the total germination. The growth of these plants was not as vigorous as that of those from the treated seed.

Many treated seeds were grown in pots. Of the plants to be used for inoculation experiments, none failed to germinate; all gave clean,

healthy, vigorous plants. Some of the plants grown from untreated seed were sickly and apparently affected with disease. A suspension obtained by soaking untreated seed was used to inoculate agar plates. Among the numerous fungi found, a fusarium was isolated. This was used for inoculation experiments, details of which are given below:—

(*a*) Some clean cotton seeds were planted. Eleven days after they showed above ground they were infected with spores from an agar culture placed on the soil around each plant. In four days all the plants were affected.

(*b*) Soil was sterilized in an autoclave at 110° C. for two hours. Cotton seed was treated with sulphuric acid for fifteen minutes, washed for twenty minutes, and sown in four pots with this sterilized soil.

Five seeds were sown in each pot.

—	Treatment.	Number germinating.	Remarks.
(*a*) 1	Seeds infected from culture ..	..	
2	,, ,, ,, ..	2	Spores formed on primary leaves
(*b*) 3	Soil infected with spores ..	1	
4	,, ,, ,, ...	1	

The exact species of fusarium has not been definitely fixed. In severe cases it has entirely prevented the germination of the seed.

(2) The Effect of Varying the Time of Immersion in Sulphuric Acid.

Small bottles, each containing 100 seeds, with sufficient sulphuric acid to cover them, were used. After the period of immersion and washing the seeds were placed in damp blotting paper and incubated at 75° F. The first examination took place four days afterwards, the final examination two days later. The results are given below:—

Period of immersion.	First germination.	Final germination.	Remarks.
Minutes.	Percentage.	Percentage.	
0	86	90	
15	88	93	These plants were more vigorous and cleaner than those from untreated seed
20	86	90	
25	84	87	
30	92	94	
35	80	85	
40	84	86	
45	92	95	
60	83	86	
75	88	91	
90	91	93	
120	88	89	
240	90	94	

From this table it may be seen that the prolonged immersion of four hours did not affect the germinating capacity. Some seedlings from treated seed have been grown in pots, and have given perfectly

healthy plants and bolls. To test whether seeds could be killed with sulphuric acid some seeds were left in concentrated acid for twenty and forty hours, and subsequently washed. Germinations of 91 and 92 per cent. respectively were obtained. With the former a good, clean, healthy growth was obtained. In the second case many of the young plants were mal-formed. The sulphuric acid had decomposed the pericarp, and had begun to attack the cotyledons, or subsequent primary leaves. It is doubtful whether any of these plants would have grown much further than the seedling stage. From the data given, there seems to be little danger from too long immersion within reasonable limits.

It was thought advisable to test the effect of treating seed with sulphuric acid for varying periods, then washing, drying, and allowing it to stand for a week, and this was done. The results obtained are given below. Seeds germinated at 75° F.:—

Time immersed.	Germination percentage.
15 minutes	94
30 ,,	92
45 ,,	94
60 ,,	90
Check	90

This shows that a delay of one week after immersion before planting has no effect on germination.

When sulphuric acid and water are mixed, heat is rapidly developed. Under some conditions this may do so with explosive activity; hence sulphuric acid must always be used with great care. After treatment with sulphuric acid and subsequent draining, the seed should be placed in a large quantity of running water. An experiment was conducted by adding a small quantity of water to treated seed; the temperature rose to 180°, but with the addition of more water, it soon fell. Subsequent experiment showed that seed held in hot water at 180° F. for five minutes, failed absolutely to germinate. At 160° F. for five minutes of two samples 46 and 41 per cent. respectively germinated. The necessity for care in handling sulphuric acid cannot be too strongly impressed upon those unacquainted with its strength. If it comes in contact with the hands, it will burn them, and any splashed on clothes will damage them.

SUMMARY.

1. The spores of many serious diseases are borne in the lint attached to the seed.

2. The lint is most conveniently removed with sulphuric acid.

3. The necessity for treatment of all imported samples is shown by the isolation of a pathogenic fusarium from an imported cotton-seed sample. Its pathogenicity has been demonstrated.

4. Immersion for reasonable periods up to four hours has no effect on the capacity of the seed to germinate.

5. Finally, the seed, after immersion in sulphuric acid, should be washed in a large quantity of running water.

SCHOOL CALF CLUB.

COMPETITION AT YINNAR SOUTH.

By W. J. Yuill, Dairy Supervisor.

The small dairying district of Yinnar South is situated at the foot of some of the wildest hill country in South Gippsland. Though the population there is very small, it has been sufficient from which to elect an enthusiastic State School committee, which deserves the credit for introducing into Victoria a modified form of calf club, a movement popular in many other countries. As the average attendance of scholars at the school is only twenty-five, many of whom live some distance from the school, the enthusiasm of the committee is all the more to be admired.

"Favour" with her proud owners. This calf was awarded highest aggregate number of points in the competition, and thus won the ribbon.

A pure-bred-calf club was organized at Geelong last year, when calves were donated to the club by various breeders throughout the State. It was not possible, however, for the Yinnar South committee to secure pure-bred animals of similar age and sex; therefore the committee took what was available—grade Jersey calves.

The object of the calf club is to provide for children living in rural districts a form of pleasure of an educational nature, which will link up school work with the home industry. As the duty of calf-feeding is often allotted to children on a farm, it is hoped the club competitions will be the means of increasing the interest of children in their work, to the mutual advantage of child and calf. The excellent work of the

Bird League may be mentioned. In a single generation the spirit of indifference to our native birds has been displaced by an interest and pleasure in them.

It is safe to assume that when the interest of children is aroused in calf feeding, it will be easier to teach them that a baby calf, like other babies, needs care, and that it must be given good food in proper quantities. They will learn that the common cause of indigestion, which brings about most of the calf's ailments, undermining its constitution and stunting its growth, is improper food, and it cannot be too strongly urged upon both child and adult that during the first weeks of a calf's life, good feeding is imperative.

Winner of prize in Best Type Section—Calf owned by Reggie Holt. In the background is Eric Holt in charge of his calf.

The Competition.

In the Yinnar South competition feeding was regulated by the following few simple rules:—

(1) All calves to be of similar breeding, age and sex.

(2) Children's parents to see that the feeding with new milk is restricted to fourteen days.

(3) New and skim milk in equal quantities to be fed for the next fourteen days.

(4) After four weeks calves to be given as much skim milk as they will drink, with half a pound of prepared calf mixture. A cup of lime water to be added to feed daily.

In addition, it was arranged that the age and weight of each calf were to be recorded at a Field Day on the 23rd August, and on this day each calf was tattooed on the ear with its owner's club number.

Prizes were offered for the greatest increase of weight, for the best led calf, and for the best type of calf, and a special prize was given for the calf securing the highest aggregate number of points in the competition.

Calves were entered by fourteen children, some families having double entries.

Judging day was held on the 13th December, when the competitors again brought their calves to the weighing steward in order that the animal showing the greatest increase in weight might be found. Later, the children led the calves into the ring, where the judging of the best type and the best fed calf took place. Anxiety was expressed in many faces, and if the truth be told, also in the faces of parents. There was a good attendance of supporters, and advice was freely given to the young competitors as they entered the ring. Some of the calves were a credit to their juvenile exhibitors. They were well groomed for the occasion, and showed every appearance of having been well cared for at all times.

The Awards.

The coveted prize for the calf securing the highest aggregate number of points in the competition was awarded to the exhibit of the four Holt children It also was placed first in the section for greatest increase in weight Although rather heavy in the body, the result of too liberal feeding, this calf was a fine specimen.

The winner of the prize for the best type exhibit was the entry of Reggie Holt. It was a very fine calf, well-grown and sleek without any suspicion of grossness, though a little more feeding would have improved it.

For the best-led calf the first prize went to Norman Brewster and the second to Oswald Brewster. Several of the children experienced difficulty in leading their exhibits—a trouble due perhaps to stage fright, as much as to insufficient training.

An enlarged photograph of the first Field Day group was awarded to the owner of the best type calf, and in order that every competitor might receive some reward, it was decided to pool the whole of the money given for prizes and divide it amongst the competitors according to the percentage of aggregate points allotted to each animal entered for the competition.

Value of Such Competitions.

As a means of providing pleasure and interest and education in one branch of farm work, the calf club competitions cannot be too highly recommended to State school committees. They will undoubtedly improve the children's understanding of farm animals, and by comparing calves on judging day the young competitors will learn to observe the many points of difference which make animal study one of so much interest. In addition it should improve the relationship between the school authorities and the parents.

The committee and teacher of the Yinnar South School must be warmly congratulated on the success of their project, and it is to be hoped that the movement will spread throughout the State.

Yinnar South Calf Club Competition.

Name of Competitor.	Club Number.	Age of Calf at beginning of competition.	Weight of Calf on first field day.	Weight of Calf on final day.	Increase of weight during competition.	Points awarded in Section.	Best type Calf (possible points 20).	Best bred Calf Section (possible points 20).	Aggregate number of points (possible points 60).
		Days.	lbs.	lbs.	lbs.				
Syd, Muriel, Rene, and Nell Holt ..	7	19	87	263¼	174¼	20	15½	13	48½
Reg. and Gladys Deppler	8	21	84	256	171½	17	14	15	46
Nancy Moore	14	2	45	204	159½	14	17	14	45
Daisy and Sylvie Deppler	3	8	71	245	168	15½	15	12	42½
Reggie Holt	10	29	98	259	161½	15	19	7	41
Eric Holt	11	26	88	242	154½	13	15	11	39
Annie and Arthur Turnbull	1	6	67½	175	107½	10	12	15½	37½
Oswald Brewster	12	30	95	168	73	9	11	17	37
Reg. and Keith Nadenbouch ..	2	13	87½	238¾	151¼	12	14	11	37
Norman Brewster	13	28	90	146½	56	7	10	19	36
Jack, Dick, and Joyce Gilbert ..	4	18	84½	217¾	133¼	11	13	7	31
Alex. Miller	6	28	65	152¾	87¾	10	10	7	27
Arch and Ostle Deppler	5	8	78½	Calf could not be caught					
Freddie Peddle	9	20	84¼	Left district					

SUPPLEMENTARY LIST OF FERTILIZERS REGISTERED AT THE OFFICE OF THE DIRECTOR OF AGRICULTURE UNDER THE FERTILIZERS ACT 1915 (No. 2652) FOR THE YEAR 1923.

Description of Fertilizer.	Brand.	Nitrogen.				Phosphoric Acid.				Potash.	Price asked for the fertilizer per ton.	Where Obtainable.
		As Blood.	As Blood and Bone.	As Bone and Flesh.	As Total.	As Water Soluble.	As Citrate Soluble.	As Citrate Insoluble.	As Total.			
Mainly Nitrogenous, readily soluble.		%	%	%	%	%	%	%	%	%	£ s. d.	
Blood ..	Cockbill's Blood Manure	8·50	..	..	8·50	..	..	1·00	1·00	..	9 0 0	W. and J. Cockbill, jun., trading as J. Cockbill, 407 Post Office-place, Melbourne
Blood Manure ..	Champion ..	12·25	..	..	12·25	..	..	2·00	2·00	..	Not retailed	John Cooke and Co. Pty. Ltd., 534 Collins-street, Melbourne
Dried Blood ..	S.C. over D.B. ..	10·00	..	..	10·00	..	..	1·50	1·50	..	12 0 0	Sims Cooper and Co. Aust. Pty. Ltd., Melbourne
,, ,, ..	P.	9·00	..	..	9·00	..	..	0·50	0·50	..	15 10 0	H. C. Pannifex, 26 Market-street, Melbourne
,, ,, ..	Nifex	7·50	..	..	7·50	..	..	1·00	1·00	0·25	9 19 0	,, ,, ,,
Mainly Phosphatic, readily soluble.												
Superphosphate	W.M.L. in diamond Standard Super.	..	..	..	..	17·00	0·50	0·50	18·00	..	5 1 1	Wallaroo-Mount Lyell Fertilizers Ltd., Adelaide, South Australia
,, ,,	W.M.L. in diamond High Grade Super.	..	..	..	..	0·50	20·50	0·50	21·50	..	5 13 7	,, ,, ,,
,, ,,	Top Brand Mineral Super.	..	..	..	..	17·00	0·50	0·50	18·00	..	5 2 1	The Adelaide Chemical and Fertilizers Coy. Ltd., Currie-street, Adelaide, South Australia
,, ,,	Top Brand Special High Grade Super.	..	..	..	..	20·50	0·50	0·50	21·50	..	5 14 7	,, ,, ,,

SUPPLEMENTARY LIST OF FERTILIZERS REGISTERED AT THE OFFICE OF THE DIRECTOR OF AGRICULTURE UNDER THE FERTILIZERS ACT 1915 (No. 2652) FOR THE YEAR 1923—*continued.*

Description of Fertilizer.	Brand.	Nitrogen.				Phosphoric Acid.				Potash.	Price asked for the Fertilizer per ton.	Where Obtainable.
		As Blood.	As Blood and Bone.	As Bone and Flesh.	As Total.	As Water Soluble.	As Citrate Soluble.	As Citrate Insoluble.	As Total.			
		%	%	%	%	%	%	%	%	%	£ s. d.	
Containing Nitrogen and Phosphoric Acid—Moderately soluble.												
Blood and Bone	S.C. over B.B. ..	..	5·50	..	5·50	..	6·00	11·00	17·00	..	8 10 0	Sims Cooper and Co. Pty. Ltd., Melbourne
,, ,,	Cockbill's ..	..	5·50	..	5·50	..	4·00	10·00	14·00	..	11 0 0	W. and J. Cockbill, trading as J. Cockbill, 407 Post Office-place, Melbourne
Animal Fertilizer	H.C.P. ..	..	5·00	..	5·00	..	4·75	5·25	10·00	..	11 0 0	H. C. Pannifex, 26 Market-street, Melbourne
,, ,,	Fertbone ..	..	..	4·00	4·00	..	2·00	8·00	10·00	..	10 12 6	,, ,, ,,
,, ,,	Arc	..	..	6·00	6·00	..	5·00	7·00	12·00	..	11 15 0	,, ,, ,,
Bone Fertilizer ..	Castle ..	..	..	2·00	2·00	..	1·50	14·50	16·00	..	10 0 0	,, ,, ,,
Animal Fertilizer	Champion ..	..	5·25	..	5·25	..	7·25	5·75	13·00	..	Not retailed	John Cooke and Co. Aust. Pty. Ltd., 534 Collins-street, Melbourne
,, ,,	Elsworth's ..	..	..	3·00	3·00	1·50	4·00	9·50	15·00	..	8 0 0	William Roberts Elsworth, cr. York and Joseph streets, Ballarat
Blood and Bone	Valley ..	..	7·65	..	7·65	..	4·90	2·85	7·75	..	12 0 0	Goulburn Valley Industries Coy. Ltd., Shepparton
Bone and Super.	"Federal," B.S. No. 1	..	..	1·50	1·50	8·50	3·85	4·65	17·00	..	8 0 0	The Australian Explosives and Chemical Coy. Ltd., 370 Little Collins-street Melbourne
,, ,,	"Sickle," Mixed, A.	..	..	1·50	1·50	8·50	3·85	4·65	17·00	..	8 0 0	Cuming Smith and Co. Pty. Ltd., 65 William-street, Melbourne

SUPPLEMENTARY LIST OF FERTILIZERS REGISTERED AT THE OFFICE OF THE DIRECTOR OF AGRICULTURE UNDER THE FERTILIZERS ACT 1915 (No. 2652) FOR THE YEAR 1923—*continued.*

Description of Fertilizer.	Brand.	Nitrogen.				Phosphoric Acid.				Potash.	Price asked for the fertilizer per ton.	Where obtainable.
		As Blood.	As Blood and Bone.	As Blood and Flesh.	As Total.	As Water Soluble.	As Citrate Soluble.	As Citrate Insoluble.	As Total.			
		%	%	%	%	%	%	%	%	%	£ s. d.	
Bone and Super.	M.L. in diamond No. 1	..	..	1·50	1·50	8·50	3·85	4·65	17·00	..	8 0 0	The Mount Lyell Railway and Mining Co. Ltd., 381 Little Collins-street, Melbourne
.. ..	Wischer and Co. Pty. Ltd., No. 1	..	..	1·50	1·50	8·50	3·85	4·65	17·00	..	8 0 0	Wischer and Co. Pty. Ltd., 153 William-street, Melbourne
Bone and Superphosphate	Elsworth's ..	..	1·50	1·50	9·00	2·50	5·00	..	16·50	..	7 0 0	William Roberts Elsworth, cr. York and Joseph streets, Ballarat
.. ..	Cockbill's ..	..	..	2·75	2·75	8·50	2·25	5·25	16·00	..	8 10 0	W. and J. Cockbill, trading as J. Cockbill, 407 Post Office-place, Melbourne

Description of Fertilizer.	Brand.	Nitrogen as Bone.	Phosphoric Acid.	Mechanical Condition.		Price asked for the Fertilizer per ton.	Where Obtainable.
				Fine Bone.	Coarse Bone.		
		%	%	%	%	£ s. d.	
Bonedust	Nova	3·00	18·00	30·00	70·00	10 5 0	H. C. Pannifex, 26 Market-street, Melbourne

Melbourne, 14th February, 1923.

P. RANKIN SCOTT,
Chemist for Agriculture.

METEOROLOGICAL OBSERVATIONS.

State Research Farm, Werribee.

Summary of observations made during 1922, and comparisons with averages of previous years :—

RAINFALL.

Average annual rainfall for forty-two years prior to 1913 .. = 20·19 inches.
Average annual rainfall for period 1913 to 1921 (9 years) .. = 19·66 ,,
Rainfall during 1922 .. .. = 19·14 ,,

BRIGHT SUNLIGHT.

Average annual total during 8-year period 1914 to 1921 = 1,990·2 hours = Daily Mean, 5·2 hours
Total during 1922 .. = 2,256·6 ,, = Daily Mean, 6·2 ,,

EVAPORATION.

Average annual total from free water surface during 8-year period 1914 to 1921 = 46·411 inches.
Total during 1922 .. .. = 45·032 ,,

MEAN AIR TEMPERATURES.

Period.	Dry Bulb.	Wet Bulb.	Maximum.	Minimum.	Mean of Max. and Min.
Average for 8 years, 1914 to 1921	58·3° F.	54·0° F.	67·3° F.	48·4° F.	57·9° F.
During 1922 ..	58·7° F.	53·6° F.	67·9° F.	47·8° F.	57·9° F.

MEAN SOIL TEMPERATURES.

Period.	At 1 Inch.		At 6 Inches.		At 12 Inches.		At 24 Inches.	
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.
Av'ge for 8 years, 1914 to 1921	68·9° F.	51·8° F.	62·3° F.	54·4° F.	60·3° F.	55·8° F.	59·3° F.	57·1° F.
During 1922	71·4° F.	51·2° F.	62·2° F.	55·1° F.	60·3° F.	56·3° F.	59·6° F.	58·0 F

MEAN OF MAXIMUM AND MINIMUM SOIL TEMPERATURES.

Period.	At 1 Inch.	At 6 Inches.	At 12 Inches.	At 24 Inches.
Average for 8 years, 1914 to 1921	60·4° F.	58·3° F.	58·0° F.	58·°2 F.
During 1922	61·3° F.	58·7° F.	58·3° F.	58·8° F.

ORCHARD AND GARDEN NOTES.

E. E. Pescott, F.L.S., Pomologist.

The Orchard.

As soon as the fruit is off the trees, the land should be well ploughed and left in a rough condition until the spring ploughing. If not already done, and the orchard conditions demand it, there is still time to put in a leguminous crop for green manuring purposes. But this should be done as early as possible, so as to give the crop a chance to make some good early growth. Soils deficient in lime or in organic matter are always benefited by a crop of green manures. Where stable manure is unprocurable, the green manure crop is the only means of adding organic matter to the soil.

Pests and Diseases.

All second-hand and old cases should be thoroughly overhauled. It is preferable to do this work now, instead of leaving it till spring, when the rush of other duties will certainly prevent it being carried out. The cases, if not bad enough to be destroyed by fire, should be dipped for some time in boiling water. And this is not only for the killing of the codlin larvæ, but also to destroy larvæ or eggs of any scale or aphis, and also any spores of fungus diseases that may have found lodgment therein.

As soon as the trees have shed their foliage they may be sprayed with lime sulphur spray for woolly aphis, peach aphis, and the bryobia mite. And this should be done before pruning, so that in handling and carrying the prunings the pests will not be spread about the orchard to infect the clean portions.

The Flower Garden.

Bulbs, tubers, and corms of spring-flowering plants should now all be planted. As they appear above ground, they should be protected from the ravages of snails and slugs, as these pests have a very great liking for these succulent growths. A good surface dressing of broken leaf or dust tobacco will effectually deal with these pests. In fact, the gardener who constantly uses tobacco, either in the leaf, stem, or dust forms, will very soon be in the happy position that slugs and snails will cause him no anxiety whatever. Besides, the tobacco has manurial properties which are also valuable.

Pansy and any other seedlings, also rooted layers and cuttings, may now be planted out into their permanent positions.

Sowings may also be made of any hardy annuals, such as antirrhinum, aquilegia, correopsis, Canterbury bell, dianthus, everlastings, foxglove, gaillardia, hollyhock, larkspur, leptosyne, lobelia, marigold, pansy, petunia, stock, sweet peas, verbena, wallflower, &c.

The Vegetable Garden.

There should now be no untidy or undug beds in the kitchen garden. The vacant beds should all be well dug over and prepared for the planting of vegetables for use in spring. In digging, a top dressing of manure should be given; this may be dug in. All weeds, too, may be forked into the trenches, and covered well with soil as each spit or length is dug. A dressing of lime is very beneficial at this time of the year three or four weeks after the manure or weed dressing.

A start should now be made at cleaning out the asparagus beds. This vegetable is most popular, and yet one rarely met with in ordinary household gardens. It is supposed to be difficult to grow, but this supposition is not borne out, as, once established, a bed of asparagus is one of the most easily managed plots in the whole garden. Depth of good soil and plenty of manure are all that this plant requires.

In establishing a new bed, it is advisable to see that there is a good depth of 2 or 3 feet of rich, well-manured soil. If this is not present, the soil should be dug out to that depth, and thoroughly mixed and enriched with well-rotted manure before being replaced. A bed deeply prepared, and supplied with ample quantities of manure, should last without replanting for very many years. The young plants or crowns should then be planted in trenches, keeping the rows 2 or 3 feet apart. An asparagus bed requires ample and direct exposure to the full rays of the sun. The asparagus should not be cut during the first season after planting; in fact, it is better to allow it to go uncut for two seasons. As little foreign weed growth as possible should be allowed in the beds, but, when they are not producing culinary asparagus, rows of lettuce, beans, radish, &c., may be grown between the crowns.

Towards the end of April the tops may be cut down, the beds cleaned and a good top dressing of stable manure given. Chemical fertilizers, such as bonedust, sulphate of ammonia, and sulphate of potash, may be given as a substitute to organic manure. In the past it has been the custom to annually top-dress the beds with salt. It was supposed that, as asparagus in its native habitat was usually found in sandy soils near the sea coast, the plant required salt or a saline soil to produce successful results. It has been found, however, that salt is not at all essential to good growth, and that the plant will readily adapt itself and grow well in soils of not at all a saline character. Where potash has taken the place of salt, quite improved results followed.

Seeds of onion, turnip, cabbage, cauliflower, carrot, and parsnip may now be sown.

REMINDERS FOR MAY.

LIVE STOCK.

Horses.—Those stabled can be fed liberally. Those doing fast or heavy work should be clipped; if not wholly, then trace high. Those not rugged on coming into the stable at night should be wiped down and in half-an-hour's time rugged or covered with bags until the coat is dry. Old horses and weaned foals should be given crushed oats. Grass-fed working horses should be given hay or straw, if there is no old grass, to counteract the purging effects of the young growth. Attend to teeth and feet of horses to be turned out for the winter.

Cattle.—Cows, if not housed, should be rugged. Rugs should be removed in the daytime when the shade temperature reaches 60 degrees. Give a ration of hay or straw, whole or chaffed, to counteract the purging effects of young grass. Cows about to calve, if over fat, should be put into a paddock in which the feed is not too abundant. Calves should be kept in warm dry shed. Observe strict cleanliness in feeding to avoid losses and sickness incidental to calf-rearing.

Pigs.—Sows not already served should be put to the boar. Supply all pigs with plenty of bedding, and see that sties are warm and well ventilated. Supply sows liberally with grain. Castrate young boars as early as possible. Pigs should be highly profitable now, as pork is very dear. Rape barley (especially skinless), oats, &c., may be sown for grazing during winter. Crushed oats will be the most economical feed for pigs at present prices.

Sheep.—Keep in-lamb ewes in strong condition. Best lambing results are obtained when ewes are neither too poor, nor excessively fat. Once the lambs arrive then the most liberal treatment possible is in the main the most profitable. Ill-fed ewes are bad mothers, indifferent to the new-born lamb, and rearing them badly afterwards, particularly very young or very old ewes. Select fine weather for lamb-marking. Yard lambs over night. Never castrate or tail high-conditioned lambs immediately on being run in and overheated. The risk with large lambs will be lessened if they are allowed to stay in the yards an hour or two after castration and the coagulated blood drawn, which in many cases will be found retained in the groin and purse, no matter what method of opening the purse is used. In tailing never draw tails tight. Projecting bone delays healing, especially when cutting off with hot blades. Even with the knife leave enough loose skin to come over and cover the vein and check the usual strong rush of blood from lambs on well-fed mothers.

Poultry.—Feed animal food to forward pullets, about ½ oz. daily, and equal parts heavy oats and broken maize at night. Add lucerne chaff to mash daily. See that fowl houses are free from draughts to avoid colds, also that they are free from red mites. Use Epsom salts freely to avoid Roup and Chicken Pox.

CULTIVATION.

Farm.—Dig main crop potatoes. Push on with ploughing and sowing of cereal crops, including peas and beans Green fodder (as for April) may still be sown. Land for maize, potatoes, and other root crops should be prepared and manured. Flax may be sown. Transplant Chou Moellier and Giant Drumhead cabbage plants in rows 3 feet apart. Complete sowing permanent pastures with grasses and clovers.

Orchard.—Plough, manure; apply lime to orchard lands at rate or 5 or 10 cwt. per acre where soil is sour. Spray trees infested with scale insects, Woolly Aphis, and Bryobia Mite with red oil or crude petroleum. Clean all rough bark from trees. Commence pruning early varieties at end of month.

Flower Garden.—Digging, manuring, and pruning; trench and drain where necessary. Dress the surface with lime. Continue to sow hardy annuals. Bury all leaves, soft-wood cuttings, and weeds. Continue to plant spring blooming perennials and other plants. Plant cuttings of carnations and roses.

Vegetable Garden.—Cut down and clean out asparagus beds. Apply manure and lime dressings. Cultivate deeply. Plant out seedlings and early potatoes; sow peas, broad beans, carrots, and parsnips.

Vineyard.—Subsoil land for new plantations if not already done. This work should be carried out as long before planting as practicable. Vine-growers are warned against the too common practice of feeding off foliage after vintage. Any small advantage in the form of stock feed is only gained at the cost of a reduction in the following season's crop, owing to interference with accumulation of reserves which continues so long as the leaves remain green. Sheep, or other animals, should not be allowed into the vineyard until the leaves have changed colour. Early and deep ploughing is strongly recommended. Manures should be applied as early as possible. Peas, &c., for green manuring, should be sown without delay, in order to take advantage of early rains.

Cellars.—Rack or fill up (preferably the former) dry wines as soon as a lighted match, introduced at bung hole, is no longer extinguished. Sweet wines should also be racked and fortified to full strength.

BEE-KEEPING.

May is the last month during which bees may be examined, handled, and, if necessary, fed without risk of endangering the existence of the colonies or seriously interfering with their safe wintering. Supers (upper stories) should be removed and stored indoors in a dry place, care being taken that bee moths cannot get access to the combs. Where suitable storage room is not available indoors, the boxes of spare combs may be left outside, but should be placed underneath the box containing the cluster of bees and the entrance to the hive contracted to one-third or fourth of the summer width.

Small colonies should be reduced to one set of combs in a single story, and any combs not covered by bees are best removed if the amount of stores is insufficient and has to be supplemented by feeding sugar syrup. The amount of honey or sugar syrup necessary to carry bees safely through the winter varies according to the strength of the colony, the locality, and the earlier or later flowering of the spring flora of the district. It is therefore not possible to state what the amount should be; it may, however, be laid down as a general rule that the combs which the bees cover at this time of the year should be at least more than half-full of sealed honey or sugar syrup. When sugar syrup has to be fed to supplement the stores it should be of the density of ripe honey, or approximately two (by weight) to one of water. The simplest way of making syrup is to pour the measured quantity of dry sugar into the correct amount of boiling water, keeping it on the stove and stirrring it till dissolved. The syrup should be given blood warm in a simplicity or frame feeder inside the hive.

The third of the series of articles on the Fruit Industry of Victoria has unavoidably been held over. It is hoped to include it in the Journal for May.

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WALLABY GRASS

Native Grass - - *(Danthonia Semiannularis)*

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Some of the finest Sheep are raised on

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(1) Proves Permanent on dry uplands where introduced species die out.
(2) Will live where Cocksfoot and Rye Grass succumb for want of humidity or nourishment.
(3) Withstands drought and grows all the year round.
(4) Will thrive luxuriantly in all situations.
(5) Once established, it spreads rapidly.
(6) In all its varied forms it is one of the most nutritious grasses of Australia; Very fattening.
(7) Greatly relished by all kinds of stock.
(8) Withstands well the ravages of rabbits.

If sown alone, 12 lbs. per acre; or with other grasses, 2 lbs. per acre.

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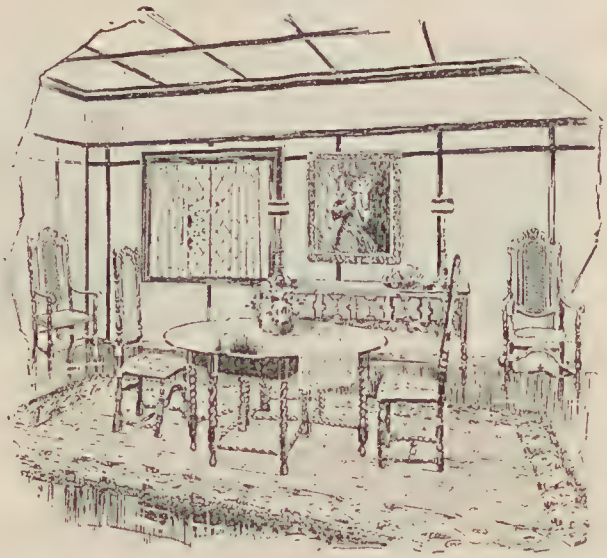

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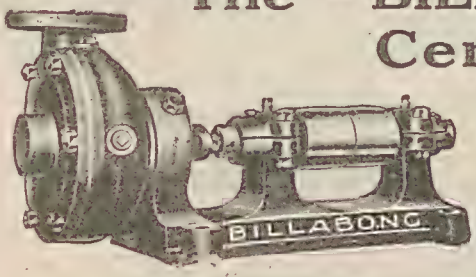

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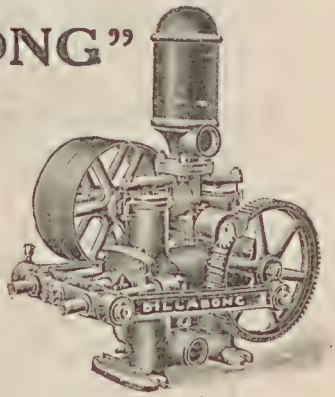

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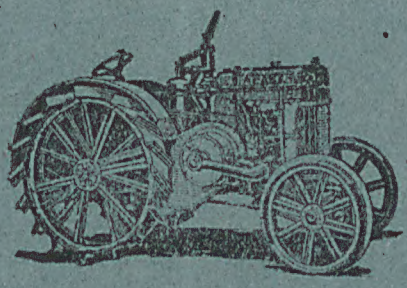

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